October 1982

DMS-DR 2508
NASA-CR 167,650

SPACE SHUTTLE AFRSI DESIGN CRITERIA DEVELOPMENT TESTS IN THE NASA/AMES RESEARCH CENTER 11x11-FOOT AND 9x7-FOOT WIND TUNNELS USING MODEL 123-Ø (OS306A/B)

by

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Prepared under NASA Contract Number NAS9-16283

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WIND TUNNEL TEST SPECIFICS:

Test Number:	548-1-11	548-1-97
NASA Series Number:	OS306A	OS306B
Model Number:	96-Ø/123-Ø	81-Ø/123-Ø
Test Start Date:	5-28-82	6-29-82
Test Completion Date:	6-3-82	7-1-82
Occupancy Hours:	80	32

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ABSTRACT

An experimental investigation (OS306A and OS306B) was conducted in the NASA/Ames Research Center (ARC) 11x11-foot and 9x7-foot wind tunnels, respectively. OS306A was conducted from May 28, 1982 through June 3, 1982. OS306B was conducted from June 29, 1982 through July 1, 1982. The purpose of these tests was to evaluate design/engineering concepts for application and repairs of the Advanced Flexible Reusable Surface Insulation (AFRSI) blanket material on Space Shuttle Orbiter (OV103) and to support the AFRSI certification program.

In both OS306A and OS306B, each specimen was subjected to the test conditions for a time duration equivalent to 400 missions (100 missions with a scatter factor of four). The test articles were AFRSI quilted blankets of varying thicknesses, in patterns duplicating the joining designs to be employed on the various areas of the Orbiter Vehicle.

Fourteen of the thirty-eight specimens (33 specimens from OS306A and 5 specimens from OS306B) survived the full simulation times without damage. Eight specimens failed during testing and the remaining eleven specimens showed some evidence of broken threads, fraying, etc.

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INTRODUCTION

Advanced Flexible Reusable Surface Insulation (AFRSI) is presently under consideration as a potential replacement for the Low-Temperature Reusable Surface Insulation (LRSI) tiles on the Space Shuttle Orbiter Vehicle. The AFRSI is a quilted blanket consisting of silica fiber felt insulation material with a quartz thread stitched through the three layers of material. The blanket IML is bonded to the skin of the vehicle while the OML face is exposed to the high-pressure gradients, fluctuating accoustic pressures, and the wind shear stresses attendant to atmospheric flight. The blankets are pliable, but individual fibrous elements are hard and brittle, and susceptible to damage, especially where they cross each other.

The purpose of these tests was to evaluate design/engineering concepts for application and repairs of the AFRSI blanket material on OV103 and to support the AFRSI certification program. Two aerodynamic shock environments were studied: an expansion/recompression shock in the 11-foot tunnel which simulated the upper canopy flow field and a compression shock in the 9x7-foot tunnel which represented the forward canopy flow field.

Test OS306A was carried out with the 96-Ø fixture at Mach numbers varying from 0.80 to 0.88 and dynamic pressures of 611 and 695 psf. The fixture leading edge flap was fixed at 18 degrees.

Thirty-three specimens were tested in OS306A. Two of these specimens (panels 201 and 202) were originally scheduled to be part of the AFRSI full-scale certification test OS305A. However, these panels failed during wind/rain testing at Eglin Air Force Base, and therefore, were included in OS306A for development studies only.

OS306B was conducted with the 81-Ø fixture, at a Mach number of 1.8 for dynamic pressures of 1060 and 1245 psf. The fixture trailing edge flap was varied between 30 and 55 degrees. Five specimens were tested in this phase.

In both OS306A and OS306B, each specimen was subjected to the test conditions for a time duration equivalent to 400 missions (100 missions with a scatter factor of four). During testing, local fixture static pressures on each side of the specimens were measured and recorded and Kulite dynamic data were obtained. All test objectives were met during both OS306A and OS306B.

This report presents information on the conduct of the test, descriptions of the test fixtures, and of the test facility, instrumentation particulars, and a sample of the pressure data collected during the test. Post-test pictures of the specimens are included.

NOMENCLATURE

SYMBOL	DEFINITION
C_p	Pressure coefficient
DEG	Degree
M	Freestream Mach number
P_ℓ	Local static pressure, psia
PSI	Pounds per square inch
PSF	Pounds per square foot
Pt	Freestream total pressure, psia
P_∞	Freestream static pressure, psia
Δp	Pressure differential across shock wave
q	Freestream dynamic pressure, psf
x	Longitudinal distance positive, inches aft of test surface leading edge
Y	Lateral distance positive, inches right of fixture centerline
δ_F	Test fixture flap setting, degrees
AFRSI	Advanced Flexible Reusable Surface Insulation
FRSI	Flexible Reusable Surface Insulation
FWD	Forward
HRSI	High-Temperature Reusable Surface Insulation
IML	Inner Mold Line
in.Hg	inches of mercury
L.E.	Leading Edge
LRSI	Low-Temperature Reusable Surface Insulation
No.	Number
OML	Outer Mold Line

NOMENCLATURE (Concluded)

SYMBOL	DEFINITION
RTV	Room-Temperature Vulcanized
SYM	Symbol
T.E.	Trailing Edge
TOC	Time on Condition
VHT	Very High Temperature (Silicon spray)

REMARKS

Kulite dynamic pressure data were obtained during the testing of each panel in OS306A and for panels 901, 902, 904, and 905 during OS306B. No Kulite data were recorded for panel 903.

During the testing of panels 901,902, and 903, 8 static taps were inoperative due to pinched tubes. These 8 static taps were located on the 81-Ø fixture at Y=14.62. Their numbers are as follows: 101, 103, 105, 107, 110, 113, 115, and 116.

All test objectives were met for tests OS306A and OS306B. During OS306A, twenty-five of the thirty-three specimens survived the full simulation time at the specified conditions. Fourteen of these specimens showed no visible damage while eleven specimens showed some signs of fraying, broken threads, etc. The remaining eight specimens failed during testing.

During OS306B, all five of the test specimens survived the full simulation time at the specified conditions. Two of these specimens showed no visible damage while the other specimens showed signs of either fraying or broken threads. Table III lists the articles tested in OS306A and OS306B and the results of testing.

CONFIGURATIONS INVESTIGATED

MODEL DESCRIPTION

The 96-Ø fixture was used for Phase A in the 11-foot Wind Tunnel. The fixture, depicted in Figure 1c, functioned to cause an expansion shock pattern ahead of the specimen, followed by a recompression shock region with attendant positive pressure gradients and high turbulence levels over the test specimen.

The mechanism employed to produce the desired expansion-recompression shocks was a full-span, 15-inch chord flap located at the forward end of the test panel and moveable through angles of zero to 30 degrees by a remotely controlled hydraulic actuator. The center of rotation of the flap was fixed at a point 2.75 inches below the top surface of the test panel at x=0.

The fixture was equipped with side plates to make the flow field two-dimensional in the test area. The plates extended from a height of 2½ feet above the top of the test panel all the way to the floor (29 inches below the test panel). The beveled leading edges were located 26 inches forward of the test specimen leading edge.

A sealed pressure box enclosed the space under the test panels. This box was vented to the tunnel plenum for these tests.

A 3/4-inch aluminum base plate (43.0 x 27.5 inches) supported by a 4.39-inch spacer was bolted to the fixture and served as the mounting surface for the test articles. The base plate open space surrounding the area reserved for specimen mounting was covered with dense foam thick enough to bring its top surface flush with the surface of the fixture.

The 81-Ø fixture was employed for Phase B in the 9x7-ft wind tunnel. This fixture, shown in Figure 1d, functioned to create a reverse flow region near the boundaries of the flap/surface corner and the boundary layer separation, together with an unsteady shock wave over the specimen. This flow phenomenon gives rise to large step-type pressure gradients and high turbulence levels.

The fixture was mounted in the ceiling of the tunnel. The flow conditions over the test area were produced by deflecting a 12-inch chord flap with a 100-inch span, located aft of the specimen holding panel. The flap, hinged on the ceiling, could be rotated from zero to 90 degrees by a remotely controlled hydraulic actuator.

A sealed pressure box enclosed the space above the specimen panel. The box was vented to the tunnel test section to permit pressure equilization across the test panels.

A 3/4-inch aluminum base plate similar to that used with fixture 96-Ø together with the 4.39-inch spacer and a 0.27-inch shim, was bolted to the fixture and served as the mounting surface for the test articles. A thick dense foam was used to fill open spaces on the base plate as in the fixture 96-Ø installation.

TEST SPECIMENS

Model 123-Ø designates a group of 38 AFRSI specimen assemblies, 33 of which were used for Phase A testing, and five for Phase B. The specimens incorporate a series of design/engineering concepts. Each test article evaluated one or two of these concepts.

The test pads consisted of AFRSI panels (12.5 x 15.5 inches) bonded with RTV to 1/8-inch aluminum backing plates (14.5 x 17.5 inches), so that the stitching loops were embedded in the bonding material. One-inch wide rectangular wooden frames surrounded the blanket material. The frame/specimen interfaces were closed off with aluminum strips which covered the top surface of the frames and extended over the AFRSI material, leaving an exposed AFRSI surface approximately 10.75x13.75 inches. The cover strip extensions were bonded to the top of the specimen material to prevent puffing of the blanket. The thickness of the assembled test pads varied from 0.67 to 1.32 inches. Figure 2 shows photographs of the test panels used in ØS306A (except for panels 201 and 202) and ØS306B.

The wind-rain panels (201 and 202) were larger in dimension than the other panels which were tested. These AFRSI blankets were bonded directly to a 27.5 x 40x1-inch aluminum plate with RTV. The polyurethane foam frame acted as a protective border around the AFRSI and also blended the varying pad thicknesses to the surrounding fixture plates. When installed, the frame of the test specimen was flush with the adjacent surface of the fixture to the extent possible, especially at the leading edge. Both panels (201 and 202) were exposed to a thermal environment (plasma arc) of 1800 deg. Figures 1e and f show sketches of panels 201 and 202.

INSTRUMENTATION

Both test fixtures were instrumented with peripheral static pressure taps and fluctuating pressure transducers. Fixture 96-Ø had 28 taps located as shown in Figure 1a and listed in Table V. Fixture 81-Ø had 24 taps located as shown in Figure 1b and listed in Table VI.

The static pressure ports were connected to six scanivalves. Rockwell furnished all necessary tubing and ARC furnished scanivalves and transducers.

Each flap drive system included a position transducer to measure the angular deflections of the flaps. ARC accepted the signals from the transducers and provided visual readouts which permitted continuous monitoring of the flap deflections. Standard ARC calibration procedures were employed for pretest calibration of pressure and position transducers and for data system checkout.

TEST FACILITY DESCRIPTION

The Ames 11x11-foot Transonic Wind Tunnel is a variable-density, closed-return, continuous-flow type. This tunnel has an adjustable nozzle (two flexible walls) and a slotted test section to permit transonic testing over a Mach number range continuously variable from 0.4 to 1.4.

The Ames 9x7-foot Supersonic Wind Tunnel is a variable-density, continuous-flow type with an adjustable nozzle to permit supersonic testing over a Mach number range continuously variable from 1.5 to 2.5. The nozzle is of the asymmetric, sliding-block type in which the variation of the test section Mach number is achieved by translating, in the streamwise direction, the fixed-contour block that forms the floor of the nozzle.

TEST PROCEDURES

The 96-Ø fixture was mounted in the 11-ft. tunnel on legs which extended through floor cutouts, to support beams located below the floor line. The beams actually supporting the model were attached to 8-inch I-beams spanning the tunnel. The floor cutouts below the model were filled in to provide smooth air flow in the area. The lines to the flap drive were hooked up to the facility's hydraulic system.

The 81-Ø fixture was installed in the roof hatch of the 9x7-ft. tunnel. The compression shock component (flap) was installed at the trailing edge of the specimen holding panel. The hydraulic drive was connected to the facility's system.

In fixture 96-Ø the test pads were mounted on the base plate at the forward end of the test surface. The leading edges of the test articles were located 1.05 inches aft of the base plate leading edge, with the longitudinal axis of the test pads coinciding with that of the base plate. In fixture 81-Ø the pads were mounted on the base plate at the geometric center of the plate.

The basic test procedure during OS306A was to first set the flap angle at 18 degrees. After tunnel drive start, the Kulite recorder was turned on. Exposure time began when q went above 400 psf. Next, the Mach number was established at 0.80 and P_t remained constant at 33 inches of mercury. The Mach number was then cycled from 0.80 to 0.88 and back to 0.80 in increments of 0.02. Data were taken at each Mach number.

This procedure was followed until the exposure time reached approximately 40 minutes. At this time, appropriate action was taken to bring the tunnel off-line. Exposure time stopped when q went down to 400 psf. Exposure time was approximately 42 minutes. Table IV shows the actual chronology for those panels that either failed during testing or followed a different procedure from the one described above.

The test procedure for OS306B was to first set the flap angle at zero degrees. After tunnel drive start, the Kulite recorder was turned on. Next, the Mach number was established at a constant 1.8. Dynamic pressure was established at 1060 psf for panels 901H, 902H, 903 and 904. Dynamic pressure was established at 1245 psf for panel 905.

The flap was then moved to 30 degrees and the exposure time was started when the flap moved from zero degrees. The flap angle was cycled from 30 degrees to 55 degrees and back to 30 degrees in 5-degree increments. Data were taken at each flap angle. The flap was cycled and data collected until 50 minutes were up. At this time the tunnel was brought off-line.

A summary of the runs completed, including the test conditions and the time-on condition for each specimen, is shown in Tables I and II.

DATA REDUCTION

Standard tunnel equations were used to compute all tunnel conditions. Local static pressure data were reduced to standard coefficient form,

$$C_p = (P_\ell - P_\infty) \times 144/q$$

Typical static pressure data for OS306A and OS306B are shown in Figure 3.

REFERENCES

1. STS82-0367, "Pretest Information for Space Shuttle AFRSI Design Criteria Development Tests OS306A/B in the Ames Research Center (ARC) 11x11-Ft. and 9x7-Ft. Wind Tunnels" (May 1982)

TEST : OS-306A

DATE : 9-13-82

TEST CONDITIONS

MACH NUMBER	REYNOLDS NUMBER (per unit length)	DYNAMIC PRESSURE (pounds/sq. ft.)	STAGNATION TEMPERATURE (degrees Rankine)
0.80	4.50×10^6	611	550
0.82			
0.84			
0.86			
0.88			
0.80	4.50×10^6	695	560
0.82			
0.84			
0.86			
0.88			

BALANCE UTILIZED: N/A

	CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:
NF			
SF			
AF			
PM			
RM			
YM			

COMMENTS:

TABLE I (Concluded)

TEST : OS-306B

DATE : 9-13-82

TEST CONDITIONS

MACH NUMBER	REYNOLDS NUMBER (per unit length)	DYNAMIC PRESSURE (pounds/sq. ft.)	STAGNATION TEMPERATURE (degrees Rankine)
1.8	4.60×10^6	1060	585
1.8	5.30×10^6	1245	596

BALANCE UTILIZED: NA

	CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:
NF			
SF			
AF			
PM			
RM			
YM			

COMMENTS:

TABLE IIa

RUN SUMMARY (OS306A)
AFRSI DESIGN CRITERIA DEVELOPMENT TEST (MODEL 96-0) 11X11 ARC

TEST: OS306A DATE: September 1982

CONFIGURATION	δ_F	P_t	No. of Runs	Mach No. .80	.82	.84	.86	.88	*Planned TOC
Calibration Panel	18°	33	1						42 Minutes
1101-1128, 1700A			29						
201, 202			2	✓					
1129		✱	1						

P_t: Total Pressure (in. Hg)
TOC: Time on Condition

✱ See Table IV
*Actual TOC is shown in Table III

TABLE IIb

RUN SUMMARY (OS306B)
AFRSI DESIGN CRITERIA DEVELOPMENT TEST (MODEL 81-0) 9X7 ARC

TEST: OS306B DATE: September 1982

CONFIGURATION	M	q	No. of Runs	T.E. FLAP DEFLECTION 30	35	40	45	50	55	TOC
901-904	1.8	1060	4	✓	✓	✓	✓	✓	✓	50 Minutes
905	1.8	1245	1	✓	✓	✓	✓	✓	✓	50 Minutes

1 7 13 19 25 31 37 43 49 55 61 67 73 76

TOC: Time on condition

TABLE III a

11x11-Ft Wind Tunnel Test OS-306A Table of Test Articles

Panel	Exposure Time	*No. of Cycles	Damage to Panels as a result of testing	Test Article Description
Cal Panel	42 min	5	No visible damage	Calibration
1101	42	4	No visible damage	Inside Corner
1102	41	8	Some fabric tears	Large Radius
1103	42	4½	Had some fraying on gap filler	Sharp corner/gap filler
1104H	42	4 3/4	Had some fraying on penetration perimeter	Plugged pentrations
1105H	42	6¼	Puffy penatration plugs	Plugged penetration & gap filler
1106H	42	7	No visible damage	Non-plugged penetration & gap filler
1107H	43	8	Fraying of penetration perimeter	Non-plugged penetrations
1108	42	6½	Fabric frays	Repair Plug
1110	42	7	Slight fraying	Repair Plug & FRSI subinstallation
1111	42	7	No visible damage	Repair Plug
1112	42	6½	No visible damage	Repair Plug & FRSI subinstallation
1113	42	6 1/4	Cracked repair and slight fray	Densification Repair & gap filler
1114	42	8	No visible damage	Loose corner & densification repair
1115	42	7	No visible damage	Thick blanket
1116	42	6½	No visible damage	Thick blanket
1117	42	8¼	Crack in repair, few threads missing	Densification repair - 1200°
1118	42	7½	Loss of VHT repair	VHT repair - 1200°
1123	42	7½	No visible damage	Broken stitches & gap filler
1124	42	8	Button was blown off during run, broken threads	RTV Bleed thru/spill -1800°
1126	43	5½	No visible damage	Hydraulic Fluid Spill -1800°
1127	42	7 3/4	No visible damage	Thin blanket
1128	42	8	No visible damage	Loose edge and corner
1700A	42	9	Failure at 2 minutes as seen on post-test video tape	1700° + Rain

*The Mach No. was cycled from .80 to .88 and back to .80 in increments of .02. This process is referred to as a cycle.Data was taken at each Mach No.

NOTE: All panels listed in this table were run at P_t = 33 in. Hg and flap angle of 18°. Exposure time began when q=400 PSF and ended when q went below 400 PSF.

TABLE IIIa (Concluded)

11×11-Ft Wind Tunnel Test OS-306A Table of Test Articles

Panel	Exposure Time	No. of Cycles	Damage to panels as a result of testing	Test Article Description
1109	42	1/2	No Damage	Repair Plug
1119	14	3 1/2	Failure at 1.5 minutes	Full pad exposed to 1800° in Plasma Arc
1120	11	1 3/4	Failure at 8 minutes	Full pad exposed to 1800° in Plasma Arc and Rain
1121	10	1	Failure at 5 minutes	Full pad exposed to 1900° in Plasma Arc and Rain
1122	14	1 1/4	Failure at 1 minute	Full pad exposed to 1900° in Plasma Arc
1125	24	3 1/2	Failure at 14 minutes	Forward facing step exposed to 1800° in Plasma Arc
1129	43	1	No Damage	Δp 2.25 psi test article
201	4	1/4 (one data pt.)	Failure at 2 minutes	Specimen having a 0.27-inch thick silica cloth covering
202	4	(never achieved condition)	Failure at 2 minutes	specimen having a 0.010-inch silica cloth covering

TABLE IIIb.

9x7-ft wind tunnel test OS-306B table of test articles

Panel	Q PSF	Time On Condition	*No. of Cycles	Test article Description	Damage to panels as a result of testing
901H	1060	50 Min	6	Plugged Penetrations	Minor fabric frays
902H	1060	50 Min	7	Unplugged penetrations	No damage
903	1060	50 Min	6	Large radius	No damage
904	1060	50 Min	6½	Sharp corner	Fabric frays
905	1245	50 Min	10	Unjointed; shock $\Delta p=2.25$	Broken threads

*The flap angle was deflected as follows for each panel: 30°, 35°, 40°, 45°, 50°, 55°, 50°, 45°, 40°, 35°, 30°, (one cycle) and then repeated as many times as possible for 50 minutes. This process is referred to as cycling the flap. Data was taken at each flap angle.

NOTE: All panels were run at $M=1.8$. Time on condition began when the flap was initially moved from zero deg to begin the cycling procedure.

TABLE IV

OS306A Chronology

Test chronology for panel 1109 (repair Plug) on: June 1, 1982

Clock Hr:Min	Exposure Min	Event
14:15		Drive start
14:19	0	q= 400 psf; start exposure time
14:21 to 14:28	9	M= .80, Pt=33 in. Hg, Took data pt
14:29 to 14:36	17	M= .82, Pt=33 in. Hg, Took data pt
14:37 to 14:44	25	M= .84, Pt=33 in. Hg, Took data pt
14:45 to 14:51	32	M= .86, Pt=33 in. Hg, Took data pt
14:52 to 14 58	39	M= .88, Pt=33 in. Hg, Took data pt
14:58	39	Started down
15:01	42	q= 400 psf; end exposure time

OS306A Chronology

Test chronology for Panel 1119 (full pad exposed to 1800° in Plasma Arc)
on: June 2, 1982

Clock Hr:Min	Exposure Min	Event
18:25		Drive start
18:28	0	q= 400 psf, P_t = 33 in. Hg; start exposure time
18:29:30	1.5	Test article failed as seen on post test video tape
18:30 to 18:41	13	Mach No. was cycled from 0.80 to 0.88 to 0.80 in increments of 0.02. This was done 3½ times. Data was taken at each Mach No. Pt = 33 in. Hg.
18:41	13	Tunnel was brought down. The test article had failed.
18.42	14	q = 400 psf Pt = 33 in. Hg; End exposure time

TABLE IV (Continued)

OS306A Chronology

Test chronology for Panel 1120 (full pad exposed to 1800° in Plasma Arc and Rain) on: June 3, 1982

Clock Hr:Min	Exposure Min.	Event
14:18		Drive start
14:21	0	q= 400 psf, P_t = 33 in. Hg, start exp. time
14:23 to 14:29	8	Mach No. was cycled from 0.80 to 0.80 in increments of 0.02. Data was taken at each Mach No. P_t=33 in. Hg. 15 data points were taken.
14:29	8	Started to bring tunnel down. The panel failed.
14:32	11	q= 400 psf, P_t = 33 in. Hg; End exposure time.

TABLE IV (Continued)

OS306A Chronology

Test Chronology for Panel 1121 (full pad exposed to 1900° Plasma Arc and Rain) on : June 3, 1982

Clock Hr:Min	Exposure Min	Event
13:40		Drive start
13:43	0	q= 400 psf, P_t= 33 in. Hg, start exp. time
13.48	5	Test panel had failed as seen on past test video tape
13:45 to 13:50	7	Mach No. was cycled from .80 to 0.88 to 0.80 in increments of .02. Data was taken at each Mach No. P_t=33 in. Hg. 10 data points were taken.
13.51	8	Started to bring tunnel down. Panel had failed.
13.53		q = 400 psf, P_t = 33 in. Hg, end exp. time

OS306A Chronology

Test chronology for Panel 1122 (full pad exposed to 1900° in Plasma Arc) on: June 2, 1982

Clock Hr:Min	Exposure Min	Event
19:30		Drive start
19:33	0	q= 400 psf, P_t = 33 in. Hg, start exp. time
19:34	1	Panel failed as seen on post-test video tape
19:36 to 19:44	11	Mach No. was cycled from 0.80 to 0.88 to 0.80 in increments of 0.02. Data were taken at each Mach No. P_t = 33 in.Hg. 11 data points were taken.
19:44	11	Started to bring tunnel down. The panel had failed
19:47	14	q= 400 psf, P_t = 33 in. Hg, End exposure time

OS306A Chronology

Test chronology for Panel 1125 (forward facing step exposed to 1800° Plasma Arc)
on: June 2, 1982

Clock Hr:Min	Exposure Min	Event
17:20		Drive start
17:23	0	q= 400 psf, P_t =33 in Hg; start exposure time
17:37	14	Test article failed as seen on post test video tape
17:26 to 17:44	21	Mach No. was cycled from 0.80 to 0.86 to .80 in increments of 0.02. This was done 3½ times. Data was taken at each Mach No. P_t = 33 in. Hg.
17:44	21	Tunnel was brought down. The test article failed
17:47	24	q = 400 psf P_t 33 in. Hg; end exposure time

TABLE IV (Continued)

OS306A Chronology

Test chronology for Panel 1129 (Δp 2.25 psi test article) on: May 28, 1982

Clock Hr:Min	Exposure Min	Event
14:29		Drive start
14:31	0	q= 400 psf; start exposure time
14:37	6	M=.8, P_t= 32.56 in. Hg, took data
14:40	9	M-.82, P_t= 31.62 in. Hg, took data
14:47	16	M=.84, P_t= 27.84 in. Hg. took data
14:50	19	M=.86, P_t = 27.11 in. Hg, took data
14:52	21	M=.88, P_t = 28.05 in. Hg. took data
14:54	23	M=.86, P_t = 27.11 in. Hg, took data
14:57	26	M=.84, P_t =27.84 in. Hg, took data
15:01	30	M=.82, P_t = 31.62 in. Hg, took data
15:04	33	M=.80, P_t = 32.56 in. Hg, took data
15:06	35	M=.82, P_t = 31.62 in.Hg, took data
15:11	40	came down
15:14	43	q= 400 psf; end exposure time

Chronology for Panel 201 (Specimen having a 0.027 inch thick silica cloth covering) on: June 3, 1982

Clock Hr:Min	Exposure Min	Event
18:09		Drive start
18:12	0	q= 400 psf:start exposure time
18:14	2	M=0.80, P_t =33 in. Hg, took data point
18:14	2	M=0.81, P_t =33 in. Hg, started coming down due to torn specimen.
18:16	4	q= 400 psf, P_t =33 ins. Hg, end exposure time

TABLE IV (Concluded)

OS306A Chronology

Chronology for Panel 202(specimen having 0.010 - inch silica cloth covering) on: June 3, 1982 target P_t= 25.8 in. Hg

Clock Hr:Min	Exposure Min	Event
20:45		Drive start
20:48	0	q= 400 psf started exposure time, pt= 26.5 in. Hg
20:50	2	M= 0.80, P_t = 26.5 in. Hg, started coming down due to torn specimen. Never achieved condition
20:52	4	q= 400 psf: end exposure time

TABLE V

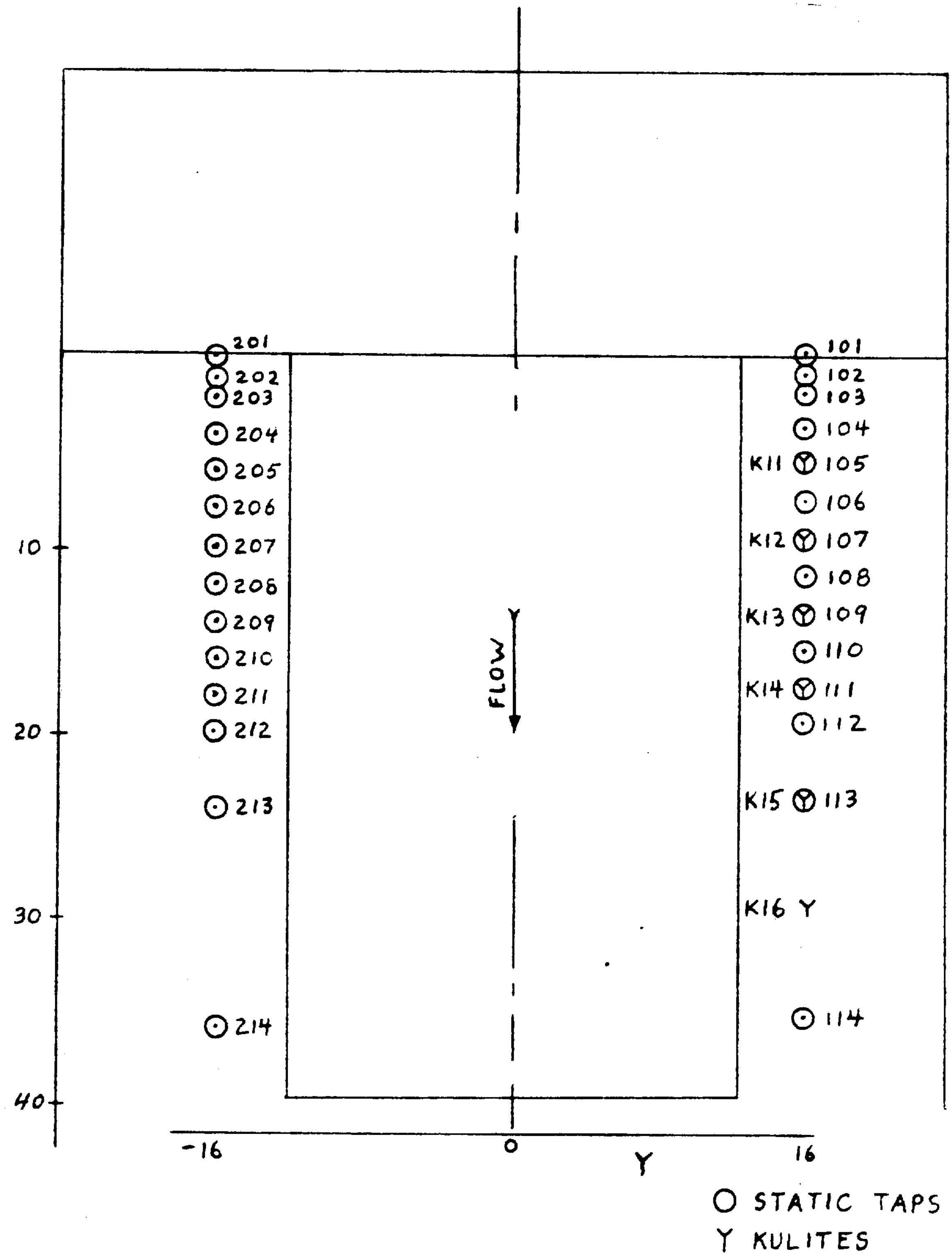
INSTRUMENTATION LOCATION, 96-∅ FIXTURE

Y / X	STATIC TAPS						Kulites at Y= 16
		-16		0		16	
0		201				101	
1		202				102	
2		203				103	
4		204				104	
6		205				105	K11
8		206				106	
10		207				107	K12
12		208				108	
14		209				109	K13
16		210				110	
18		211				111	K14
20		212				112	
24		213				113	K15
30							K16
36		214				114	

TABLE VI

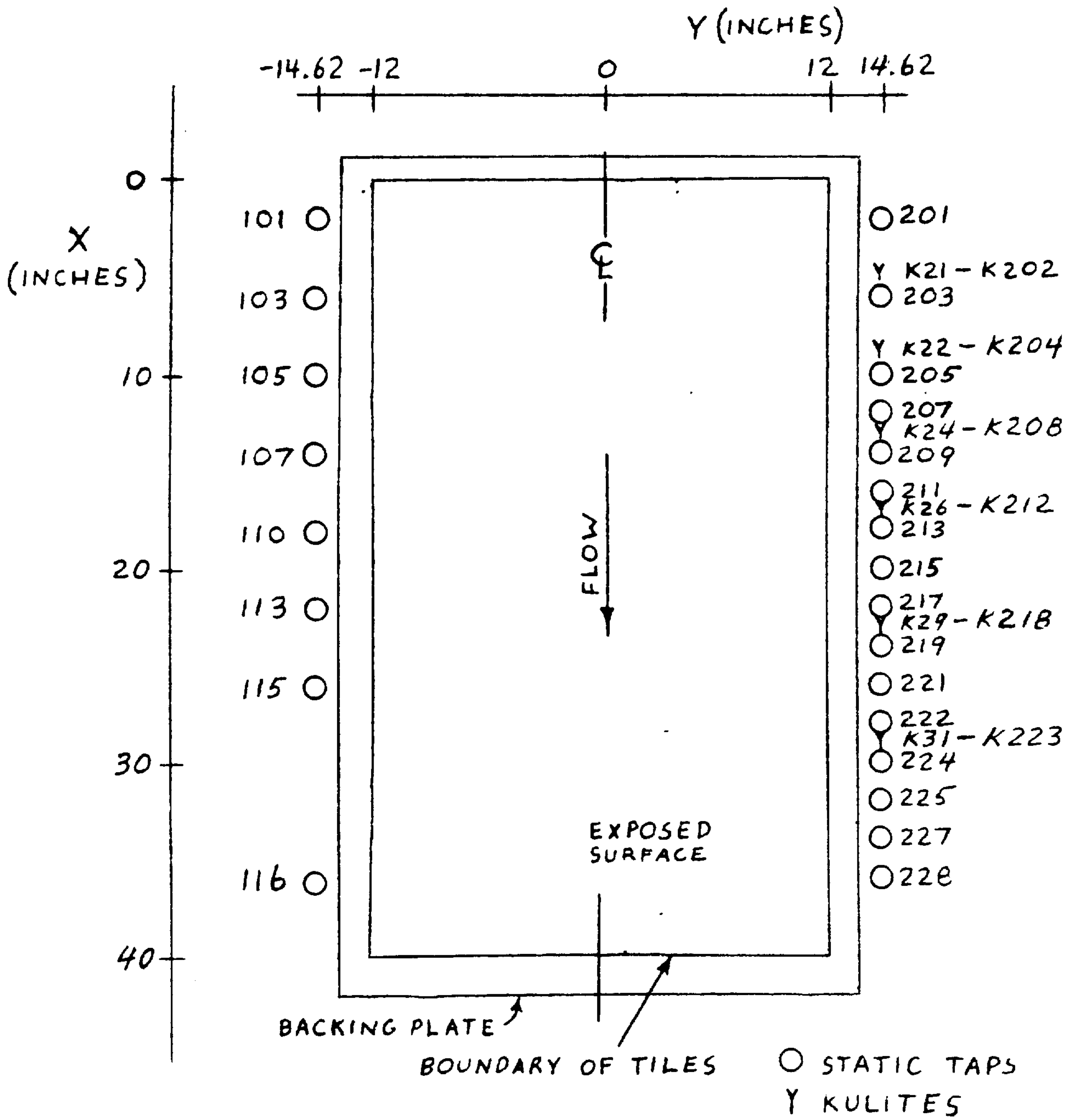
INSTRUMENTATION LOCATION, 81-0 FIXTURE

X \ Y		-14.62	:	14.62
		STATIC TAPS		
2		101		201
6		103		203
10		105		205
12				207
14		107		209
16				211
18		110		213
20				215
22		113		217
24				219
26		115		221
28				222
30				224
32				225
34				227
36		116		228
		KULITES		
5				K21
9				K22
13				K24
17				K26
23				K29
29				K31



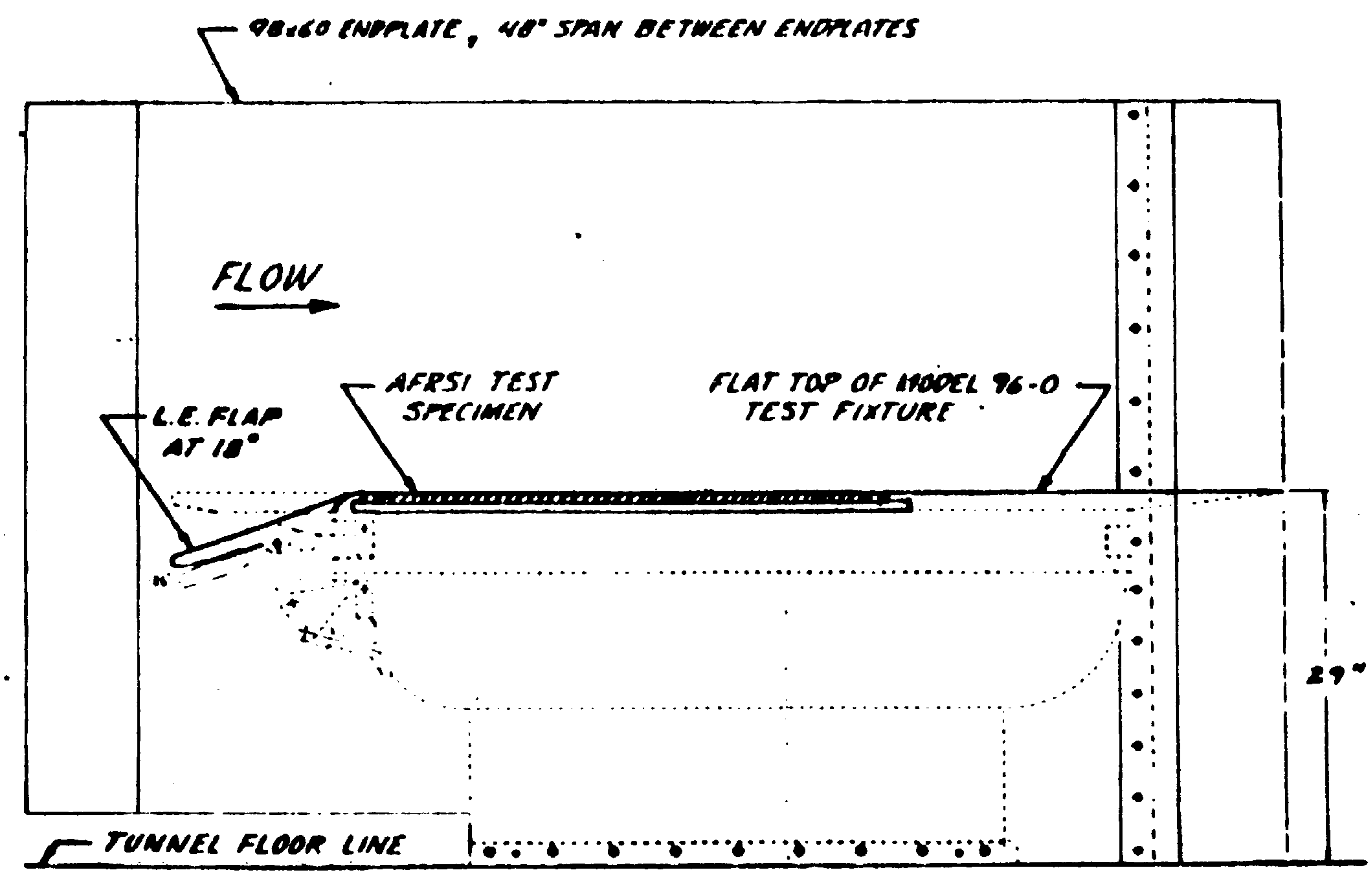
a. Instrumentation Location 96-0 Fixture (OS306A)

Figure 1. Model Figures



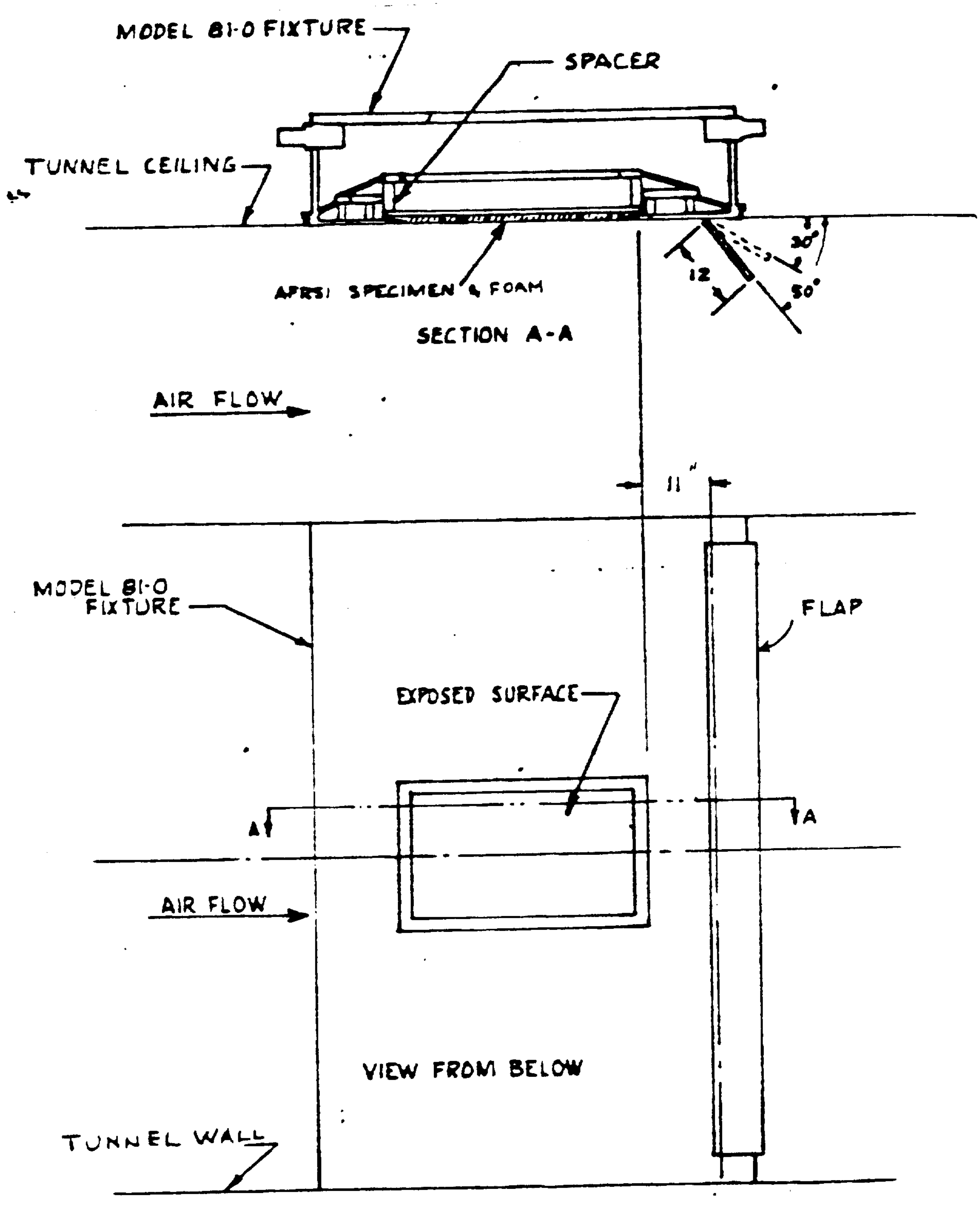
b. Instrumentation Location 81-0 Fixture (OS306B)

Figure 1. Model Figures (Continued)



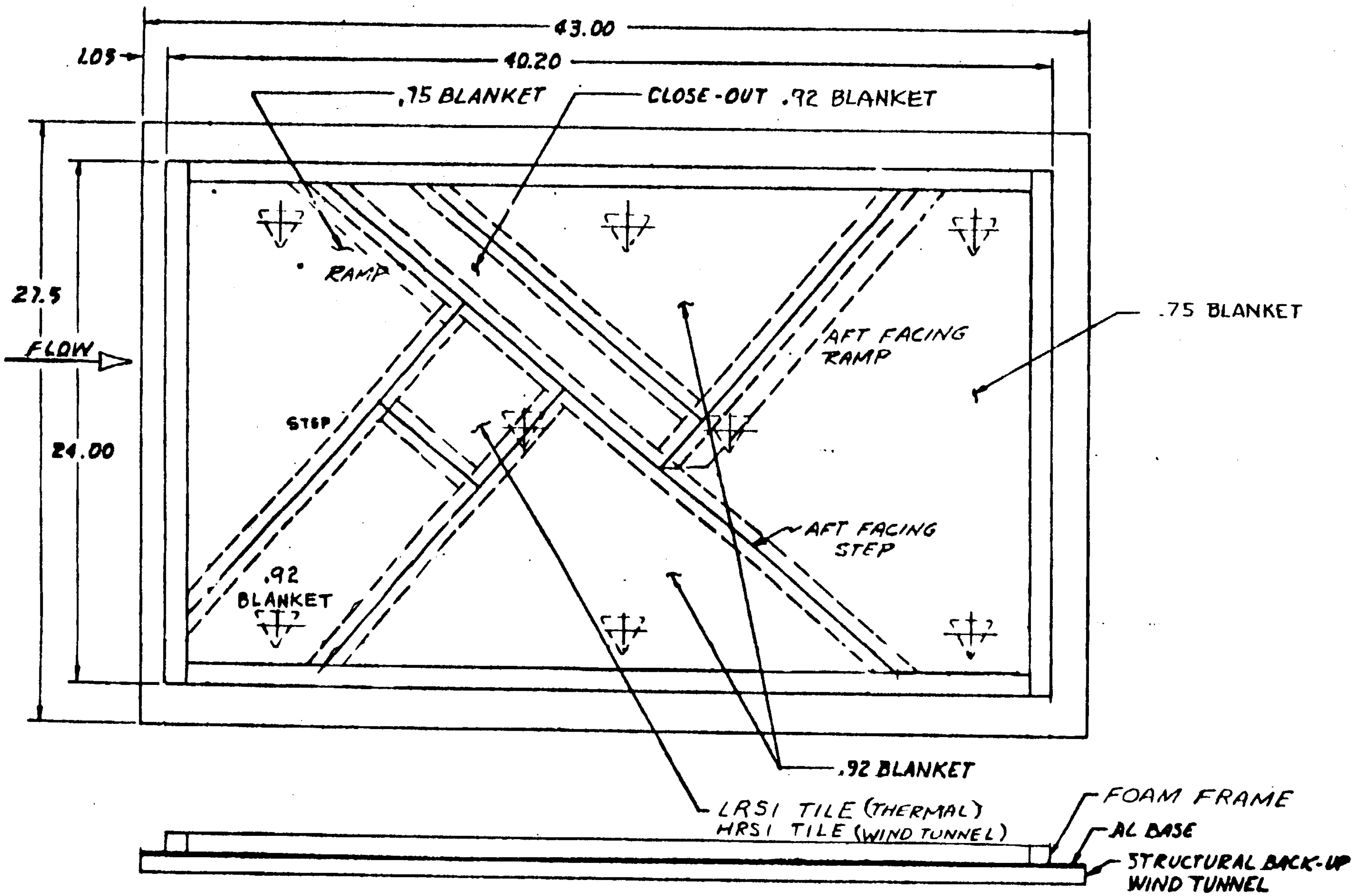
c. 96-0 Test Fixture
General Arrangement
(OS306A)

Figure 1. Model Figure (Continued)



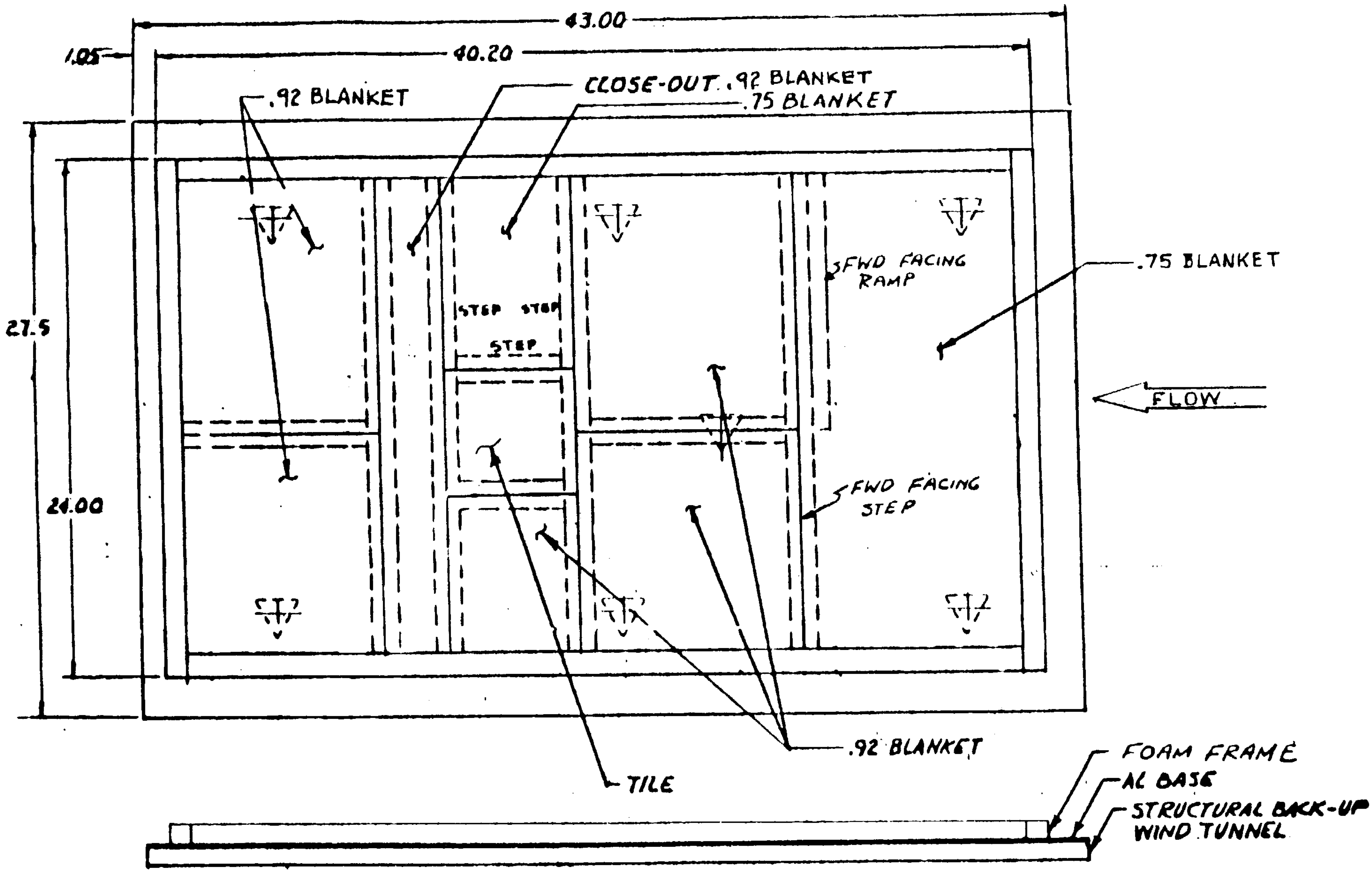
d. 81-0 Test Fixture
General Arrangement
OS306B

Figure 1. Model Figures (Continued)



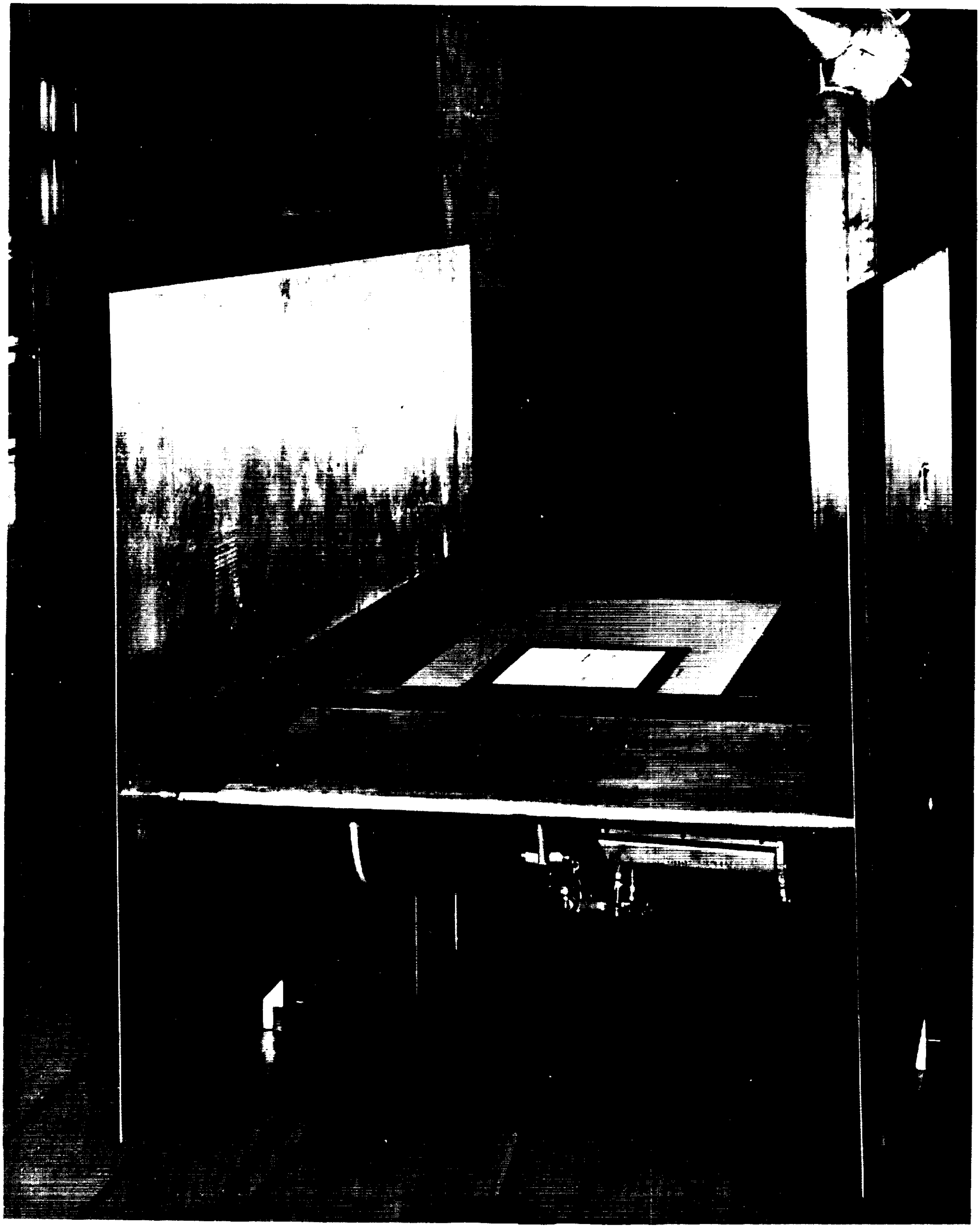
c. PANEL 202 FLEXIBLE BLANKET TEST ARTICLE CONFIGURATION
(THIN(.010 IN) FACE SHEETS)

Figure 1. Model Figures (Continued)



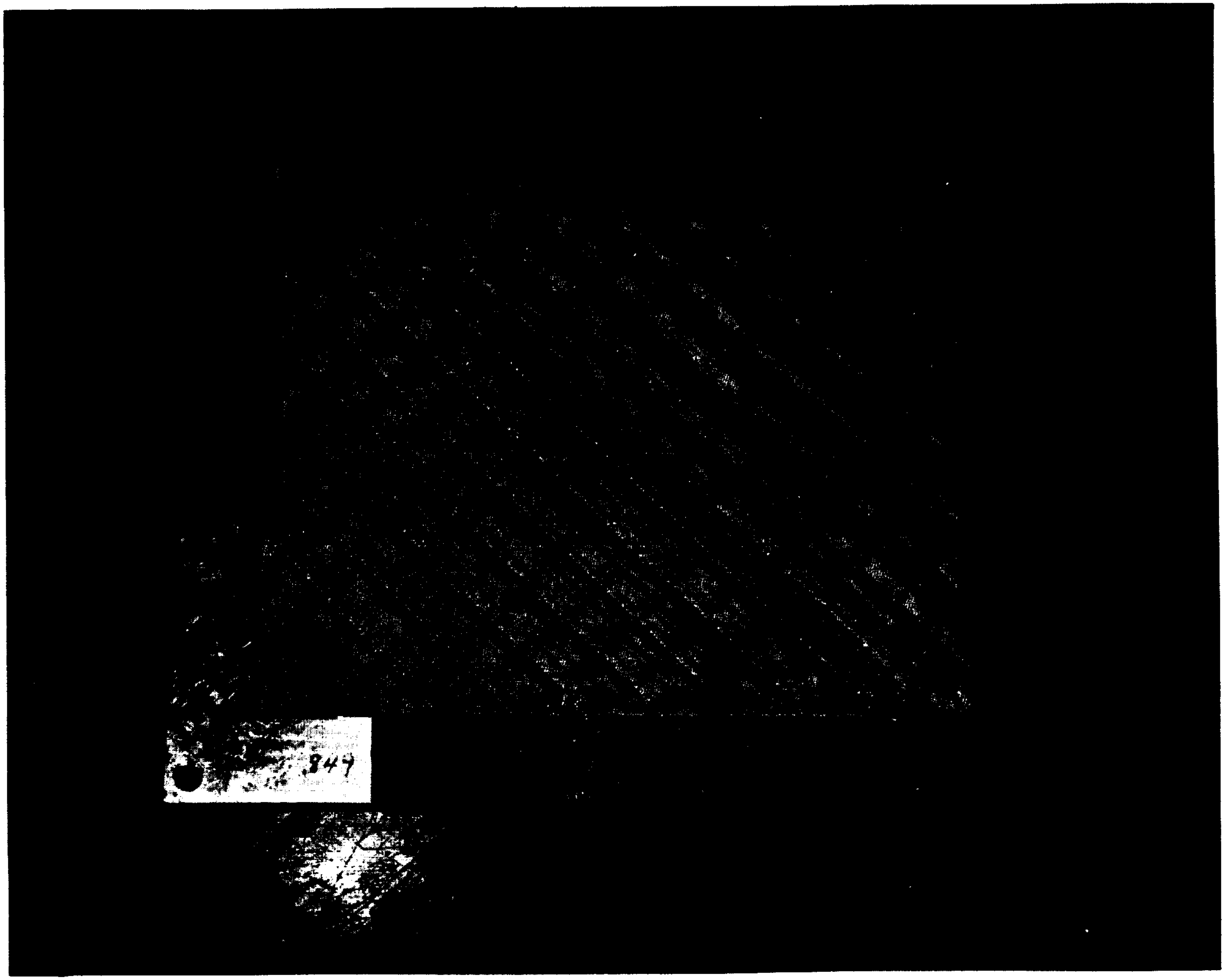
f. PANEL 201 FLEXIBLE BLANKET TEST ARTICLE CONFIGURATION (THICK (.027 IN) FACE SHEETS)

Figure 1. Model Figures (Concluded)



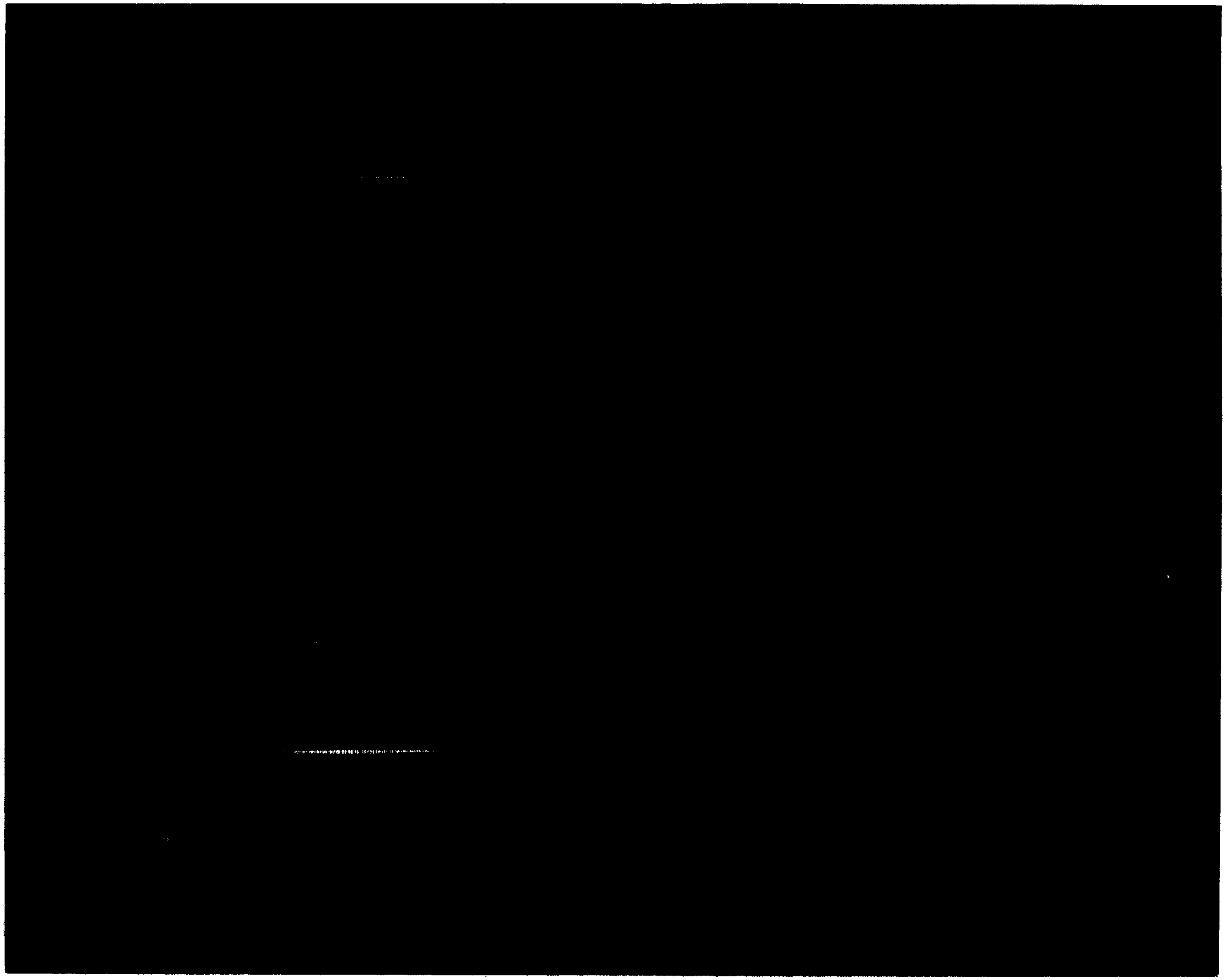
a. Installation Photograph of the 96-0 Fixture in the 11x11-Foot UPWT at ARC with Panel 1105

Figure 2. Model Photographs



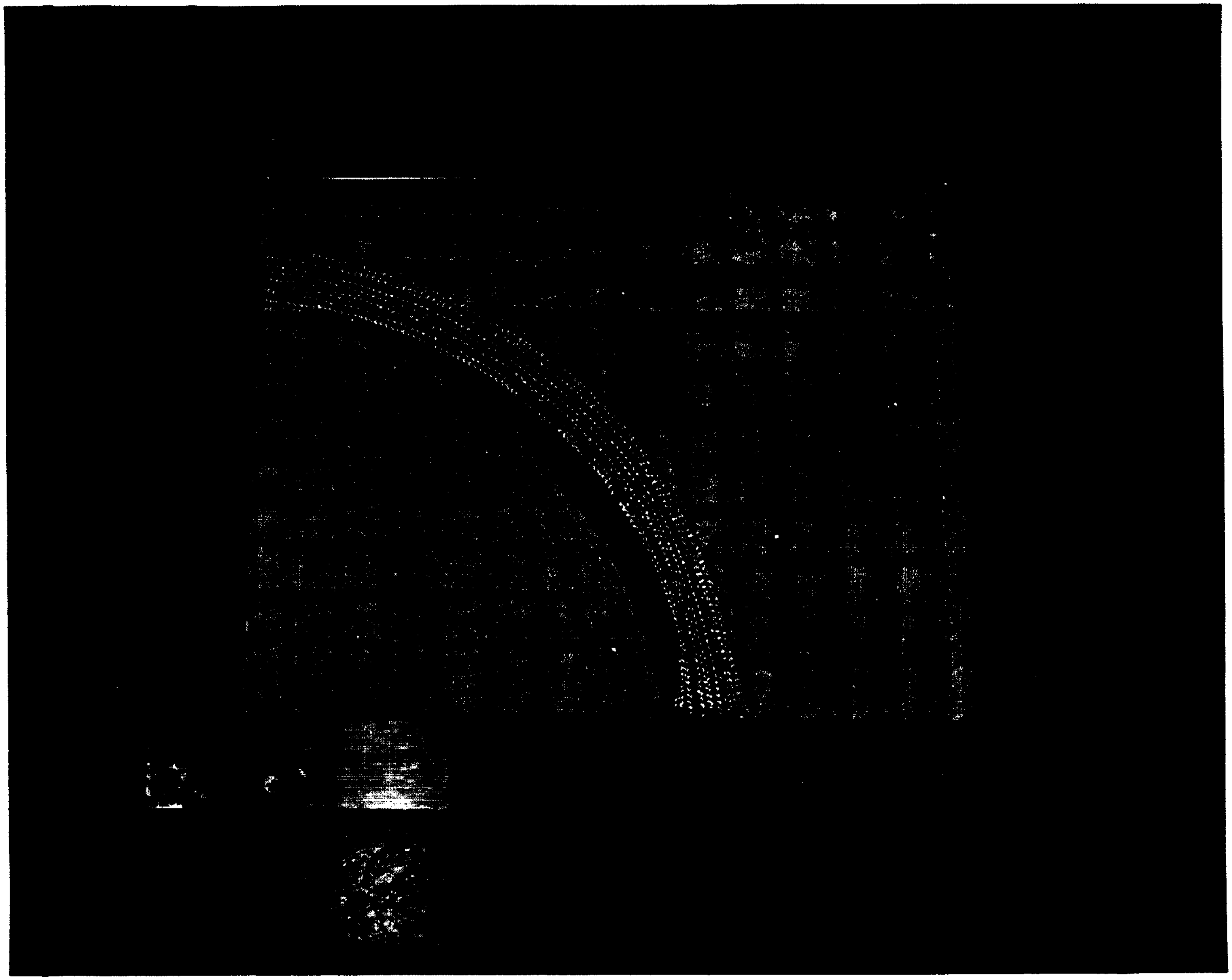
b. Calibration Panel

Figure 2. (Continued)



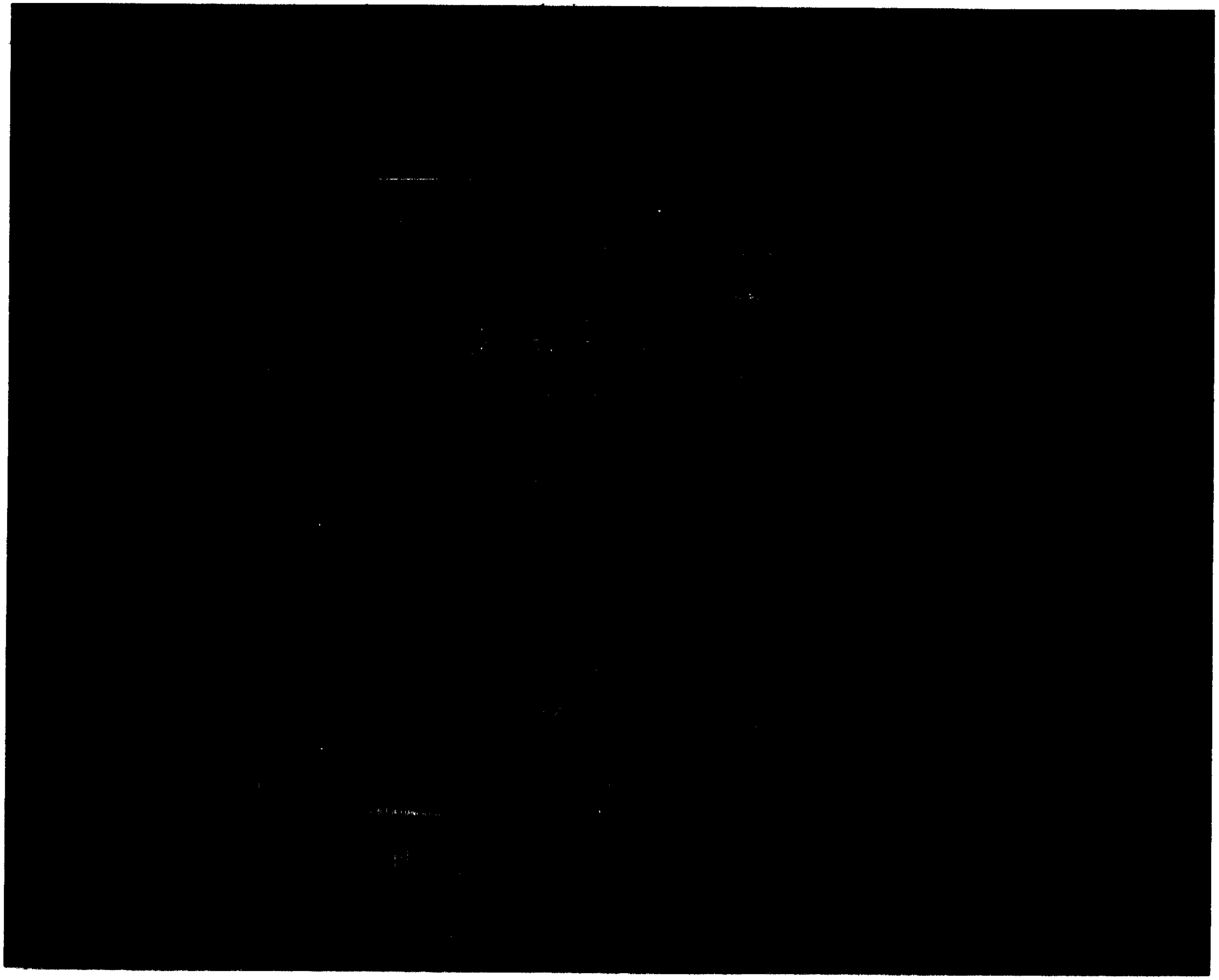
c. Panel 1101, Inside Corner

Figure 2. (Continued)



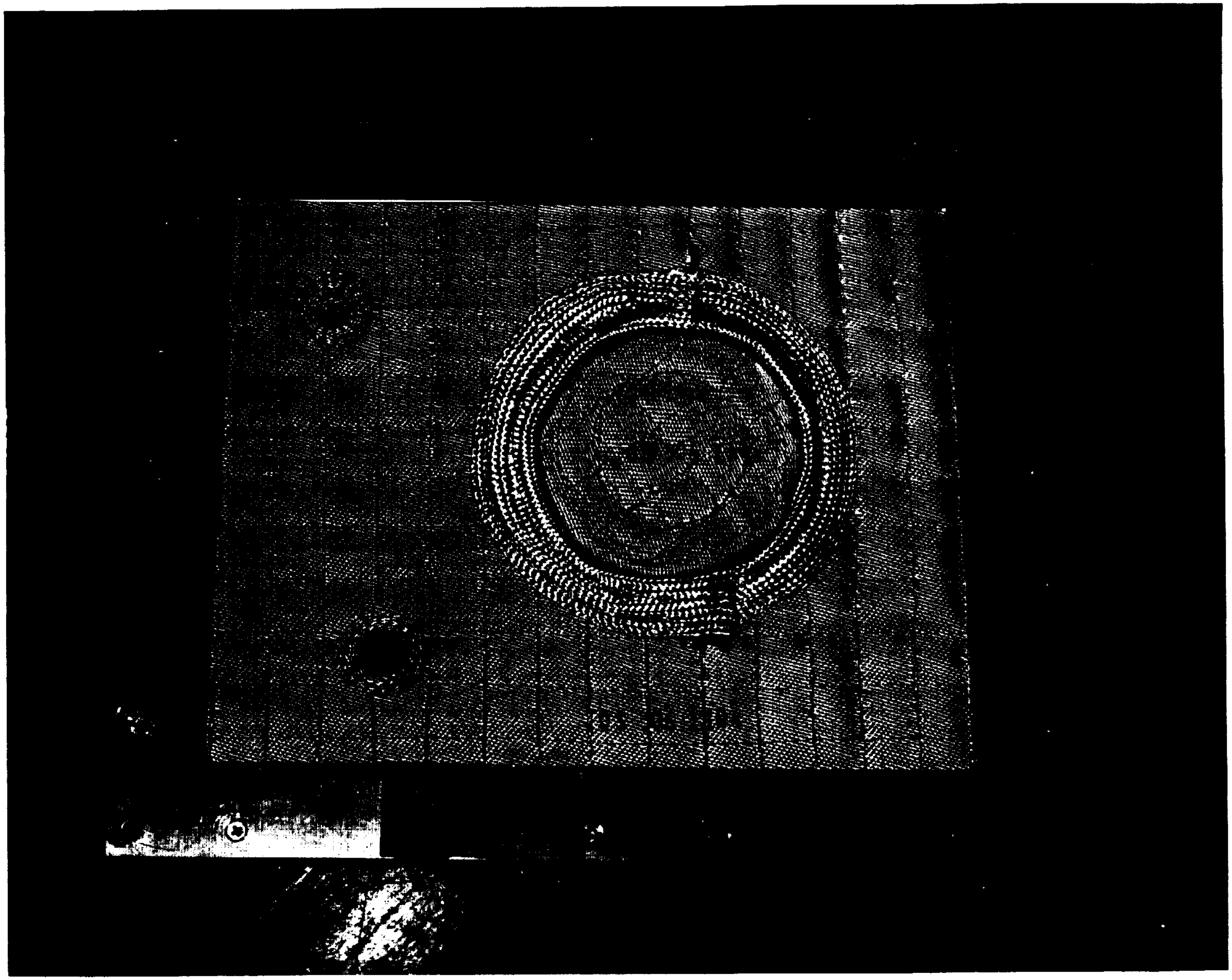
d. Panel 1102, Large Radius

Figure 2. (Continued)



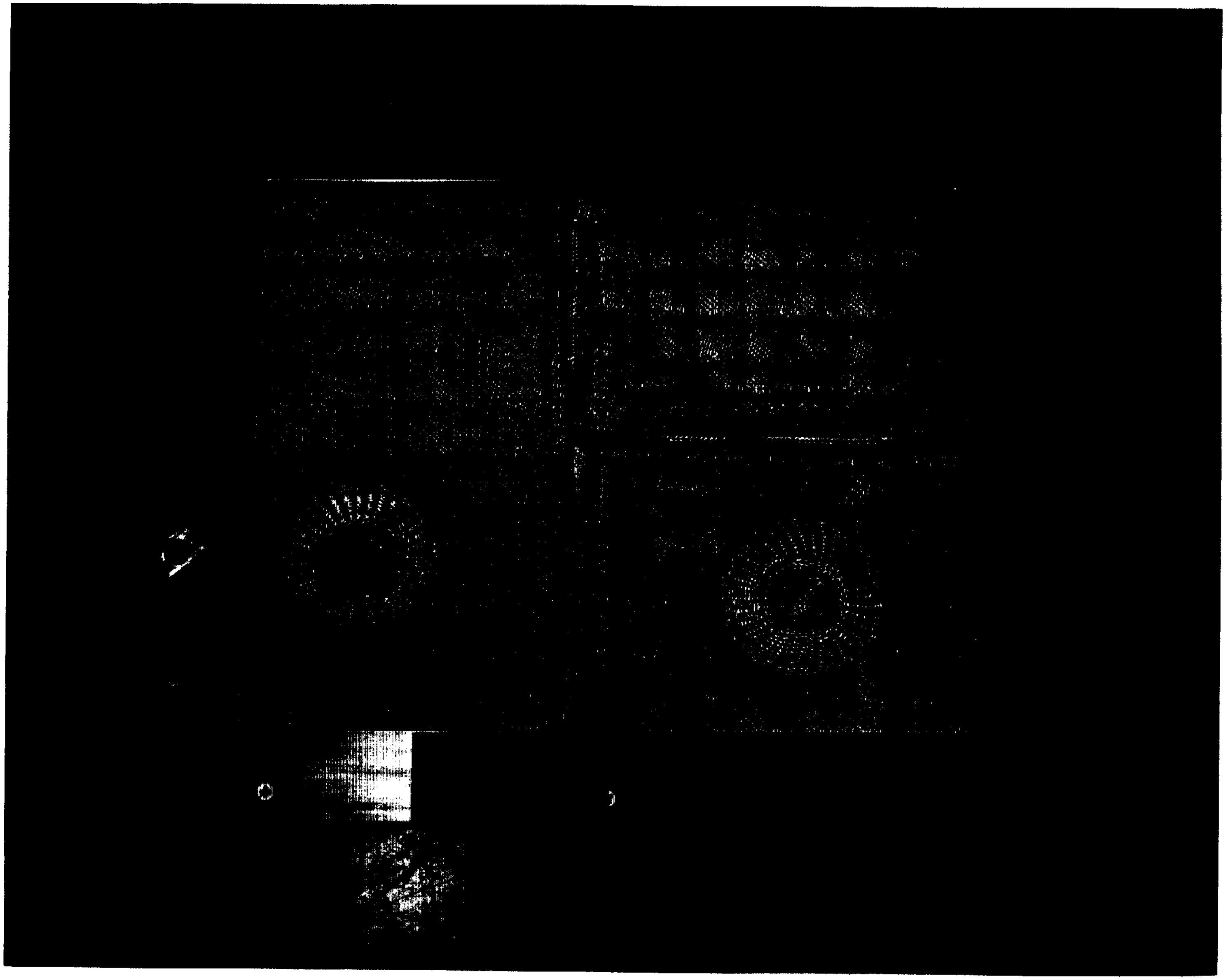
e. Panel 1103, Sharp Corner/Gap Filler

Figure 2. (Continued)



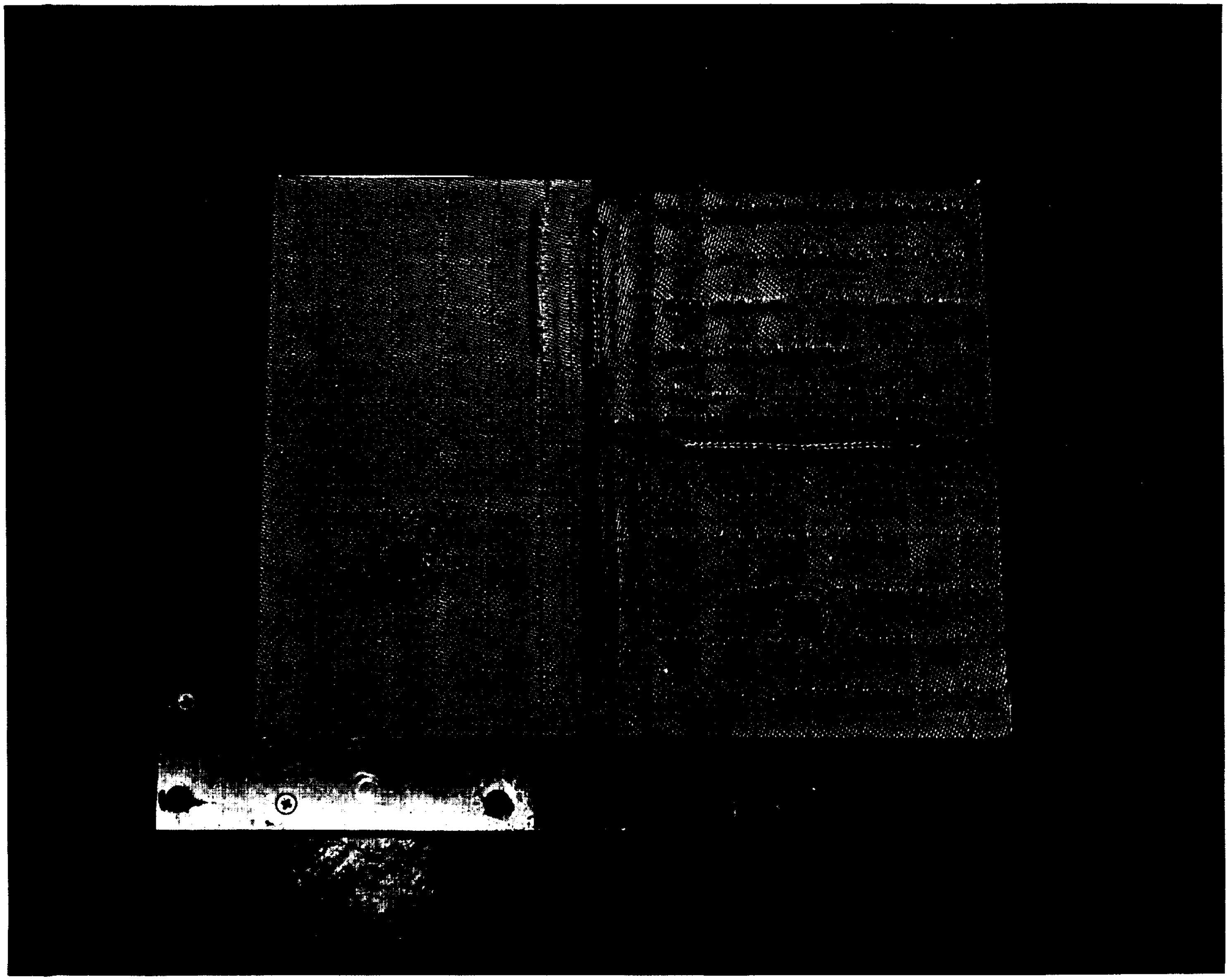
f. Panel 1104H, Plugged Penetrations

Figure 2. (Continued)



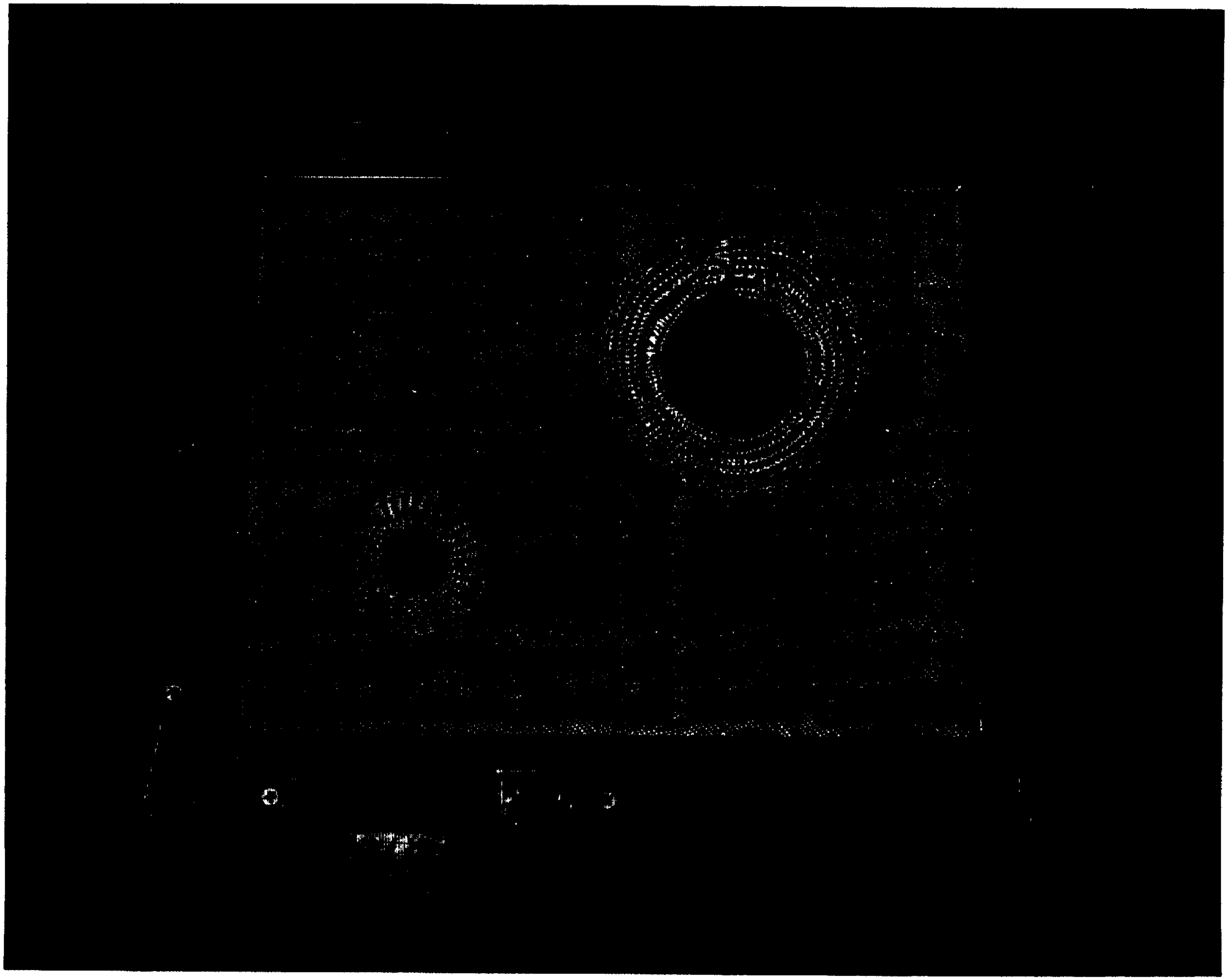
g. Panel 1105H, Plugged Penetration & Gap Filler

Figure 2. (Continued)



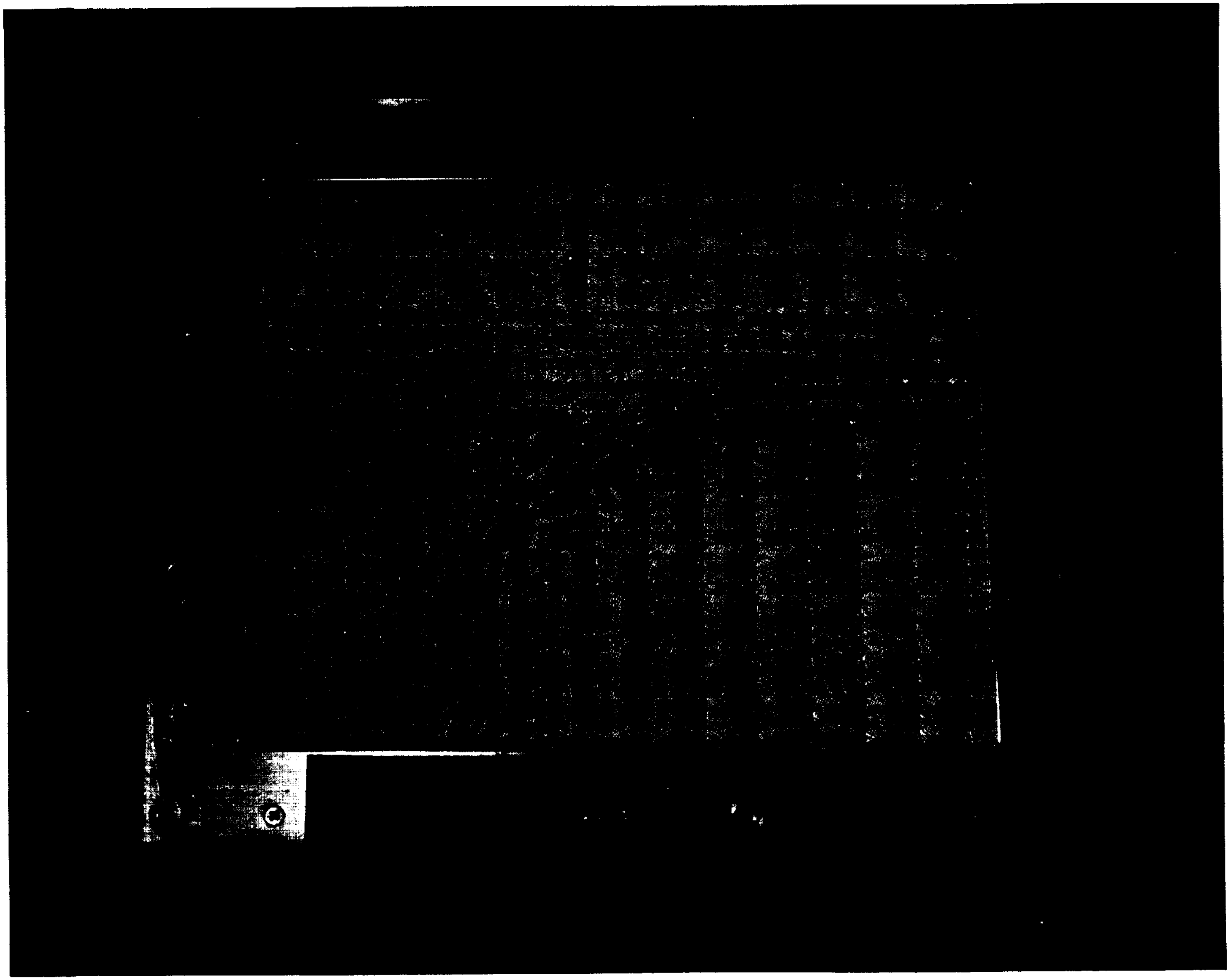
h. Panel 1106H, Non-plugged Penetration & Gap Filler

Figure 2. (Continued)



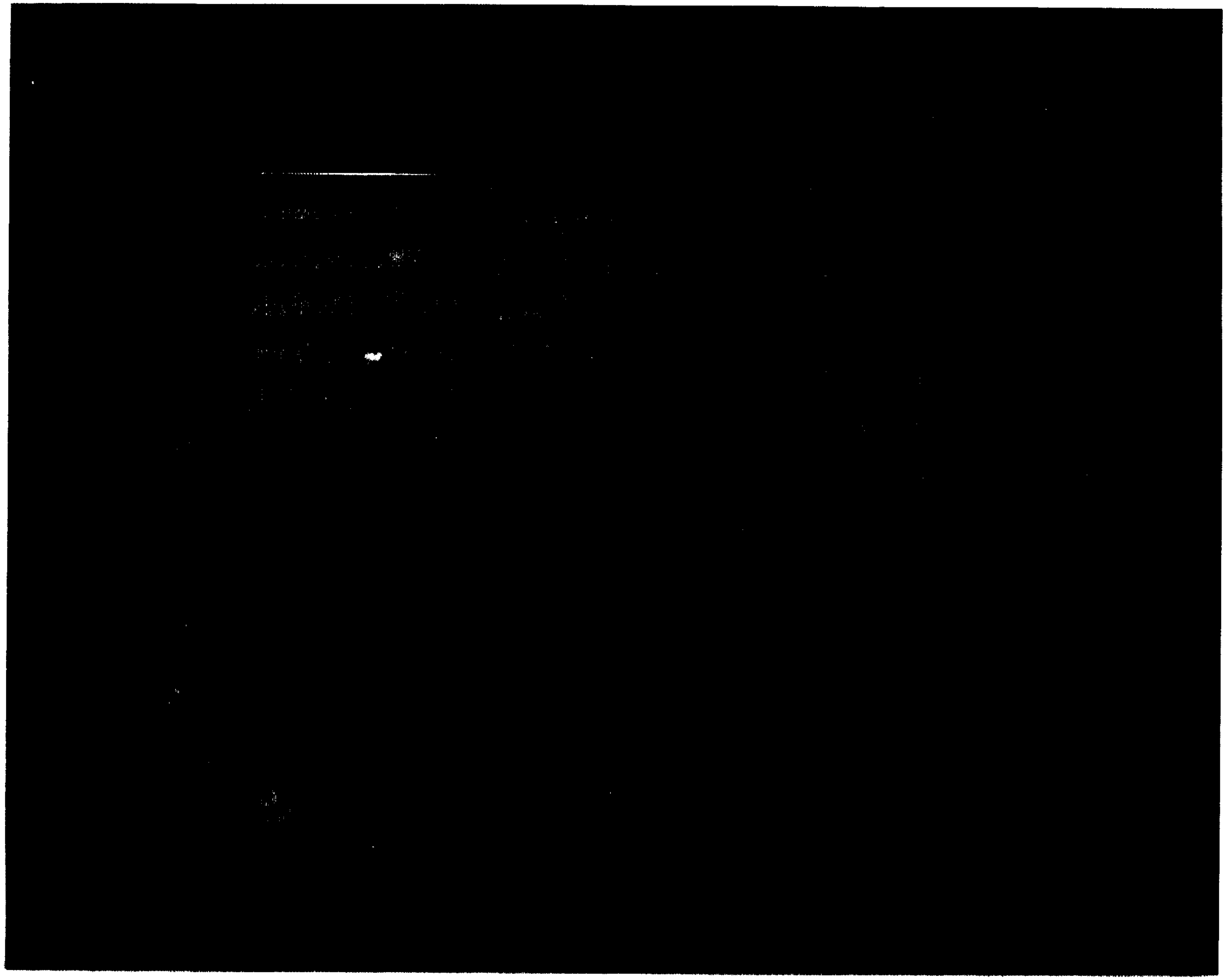
i. Panel 1107H, Non-plugged Penetrations

Figure 2. (Continued)



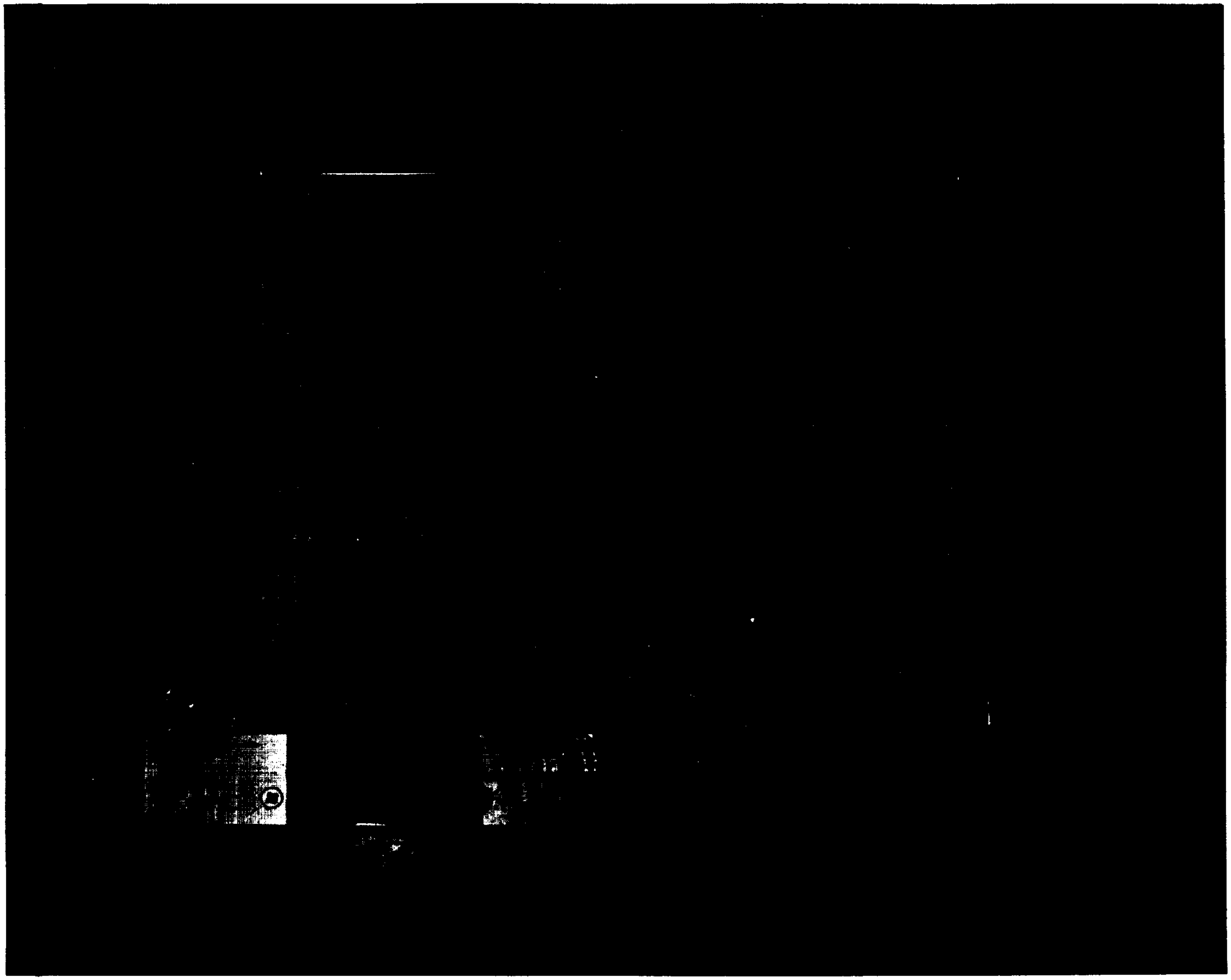
j. Panel 1108, Repair Plug

Figure 2. (Continued)



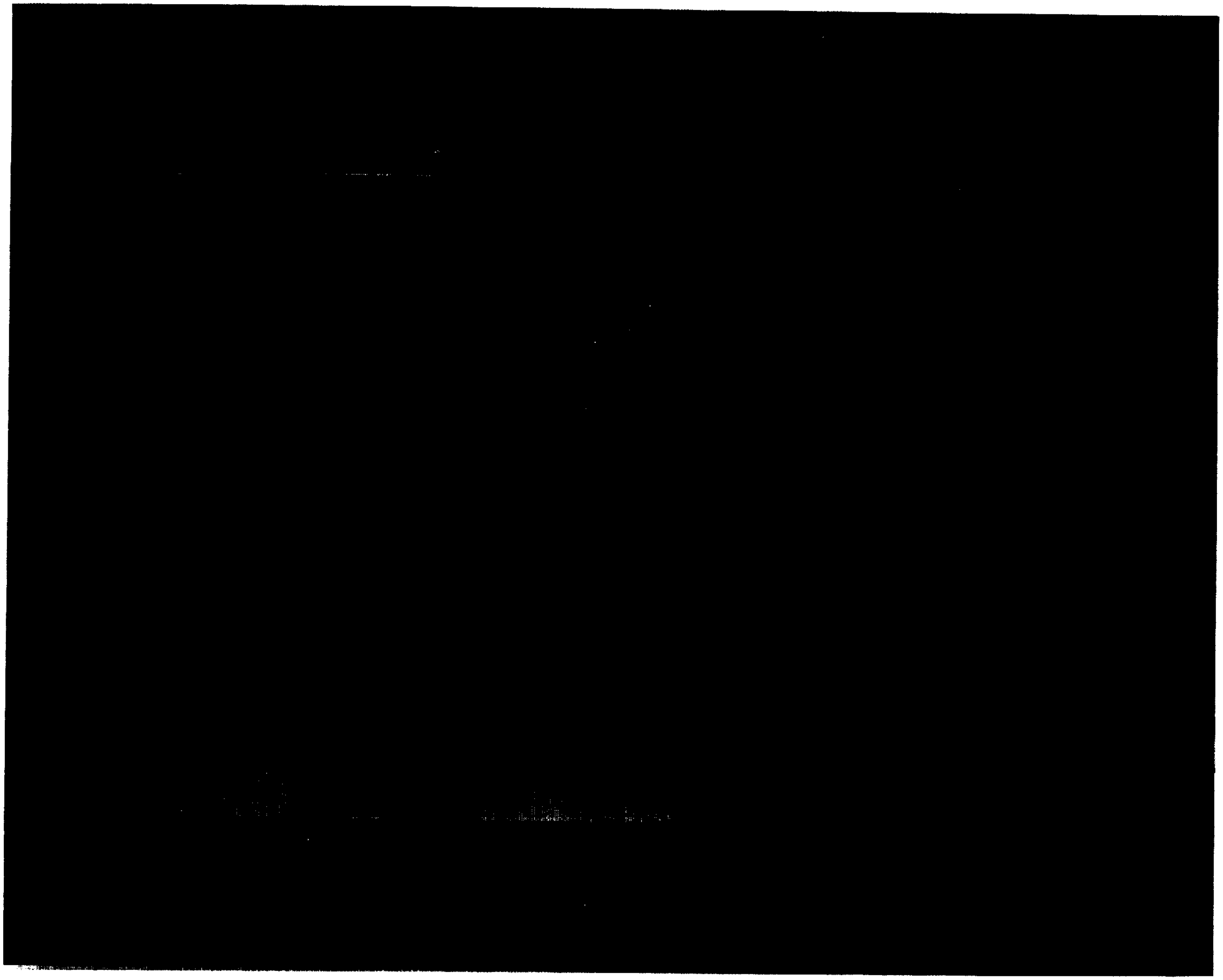
k. Panel 1109, Repair Plug

Figure 2. (Continued)



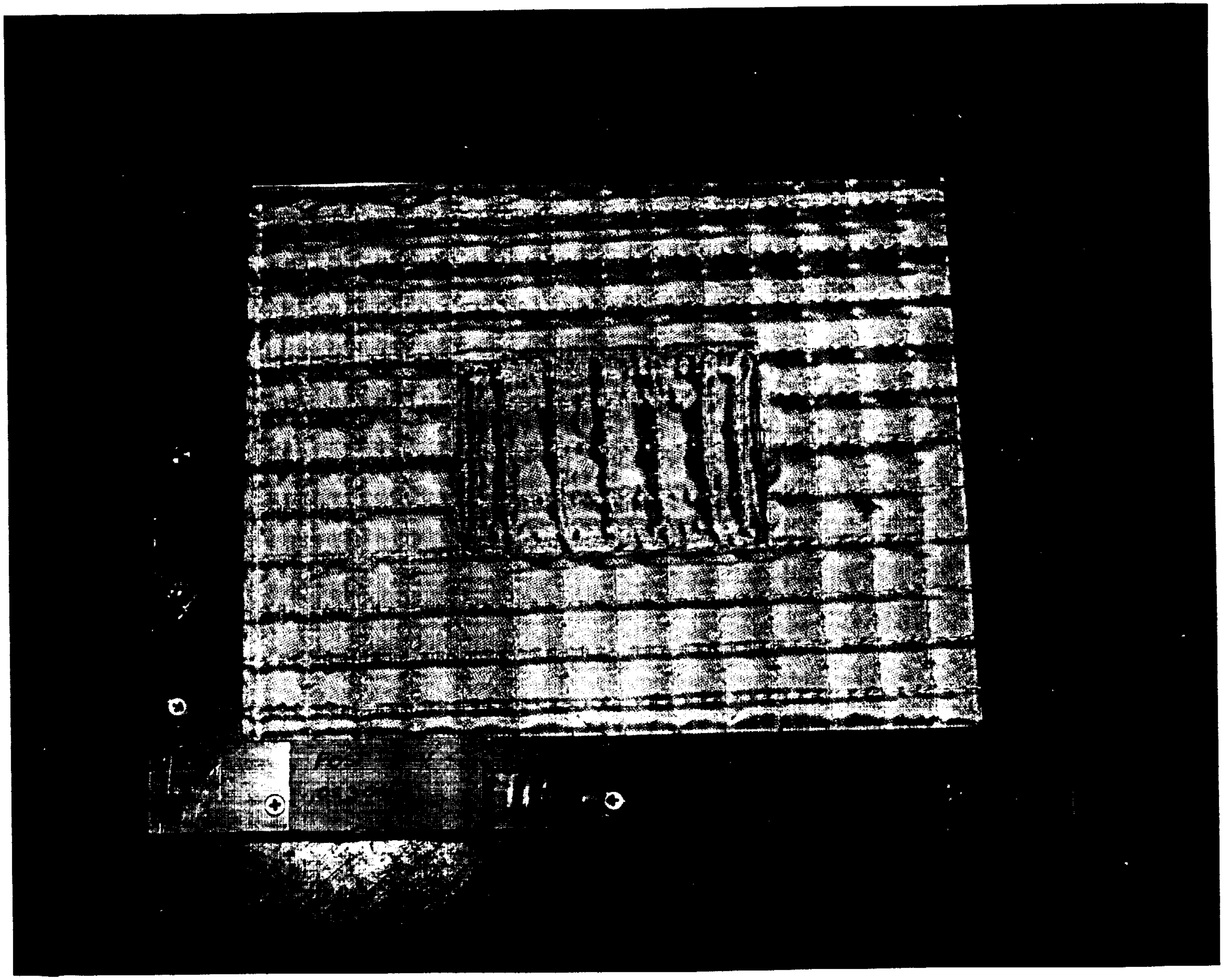
1. Panel 1110, Repair Plug & FRSI Subinstallation

Figure 2. (Continued)



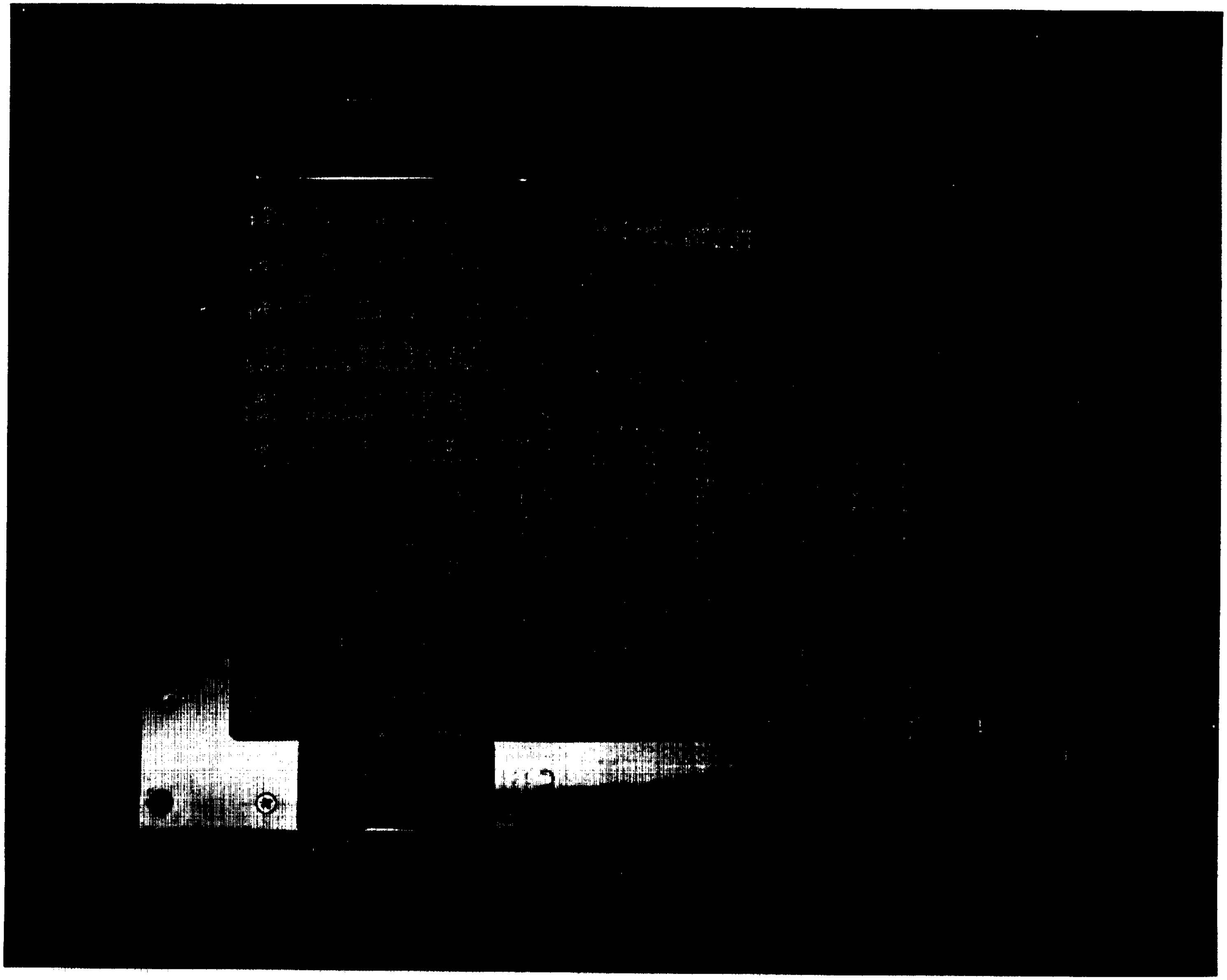
m. Panel 1111, Repair Plug

Figure 2. (Continued)



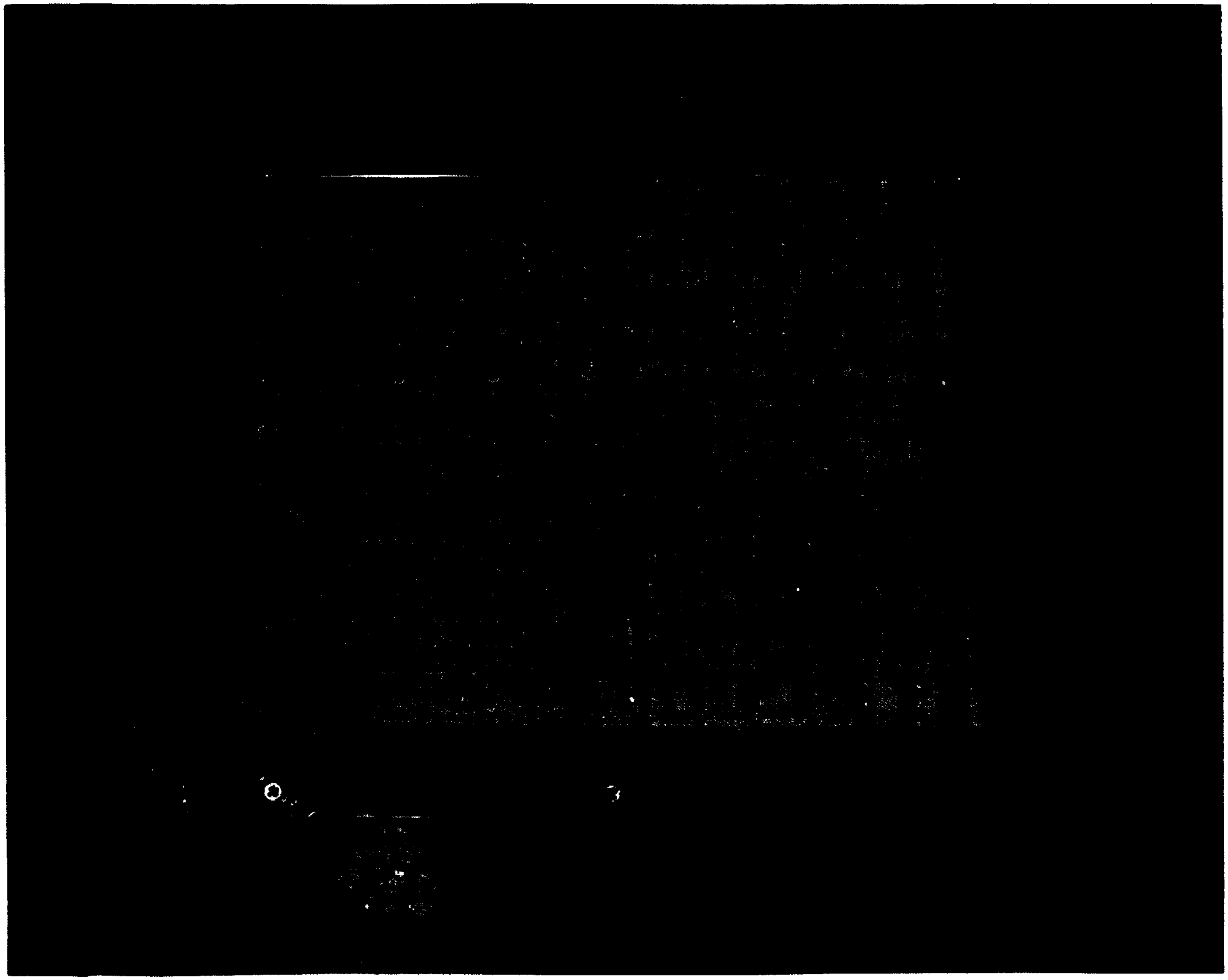
n. Panel 1112, Repair Plug & FRSI Subinstallation

Figure 2. (Continued)



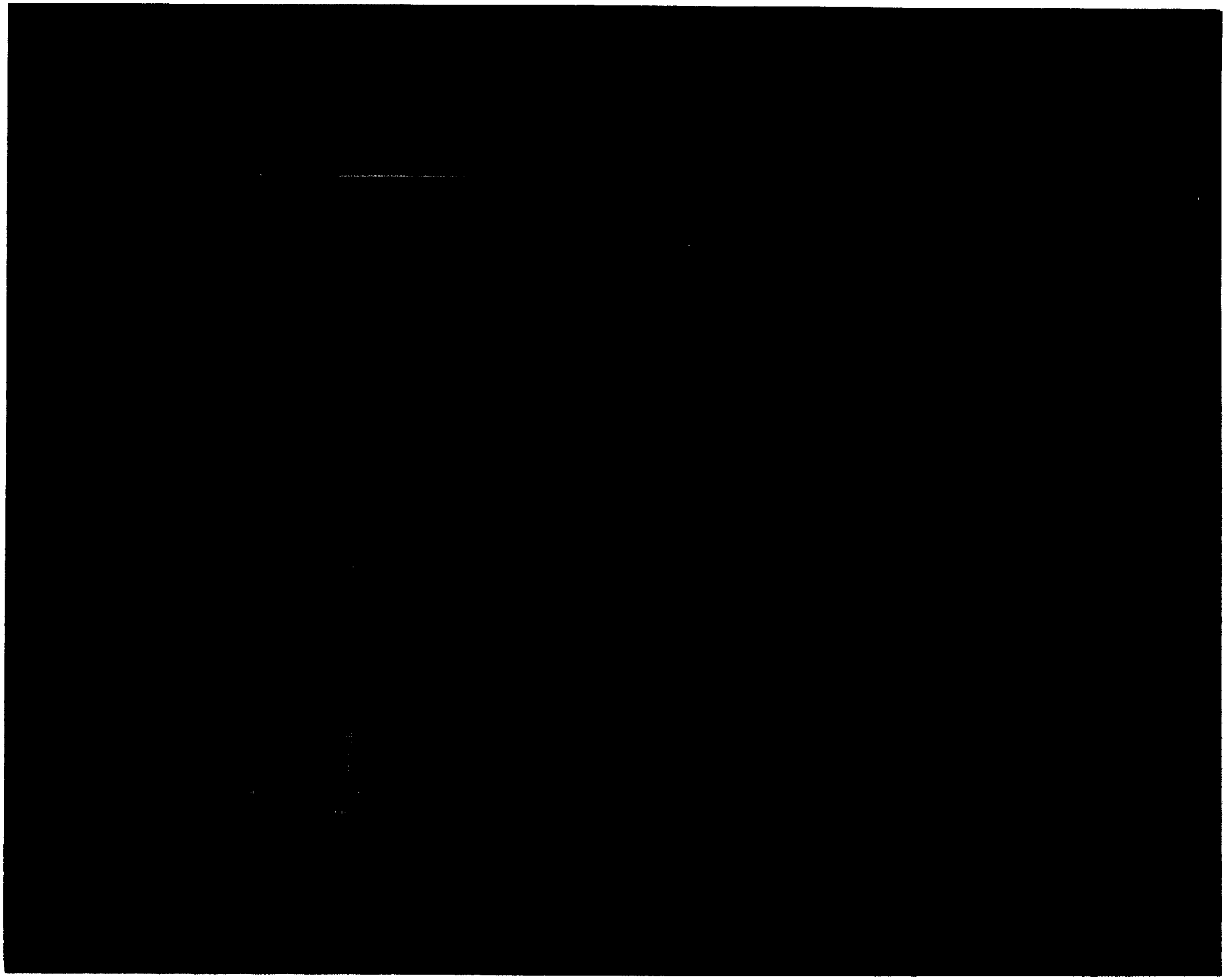
o. Panel 1113, Densification Repair & Gap Filler

Figure 2. (Continued)



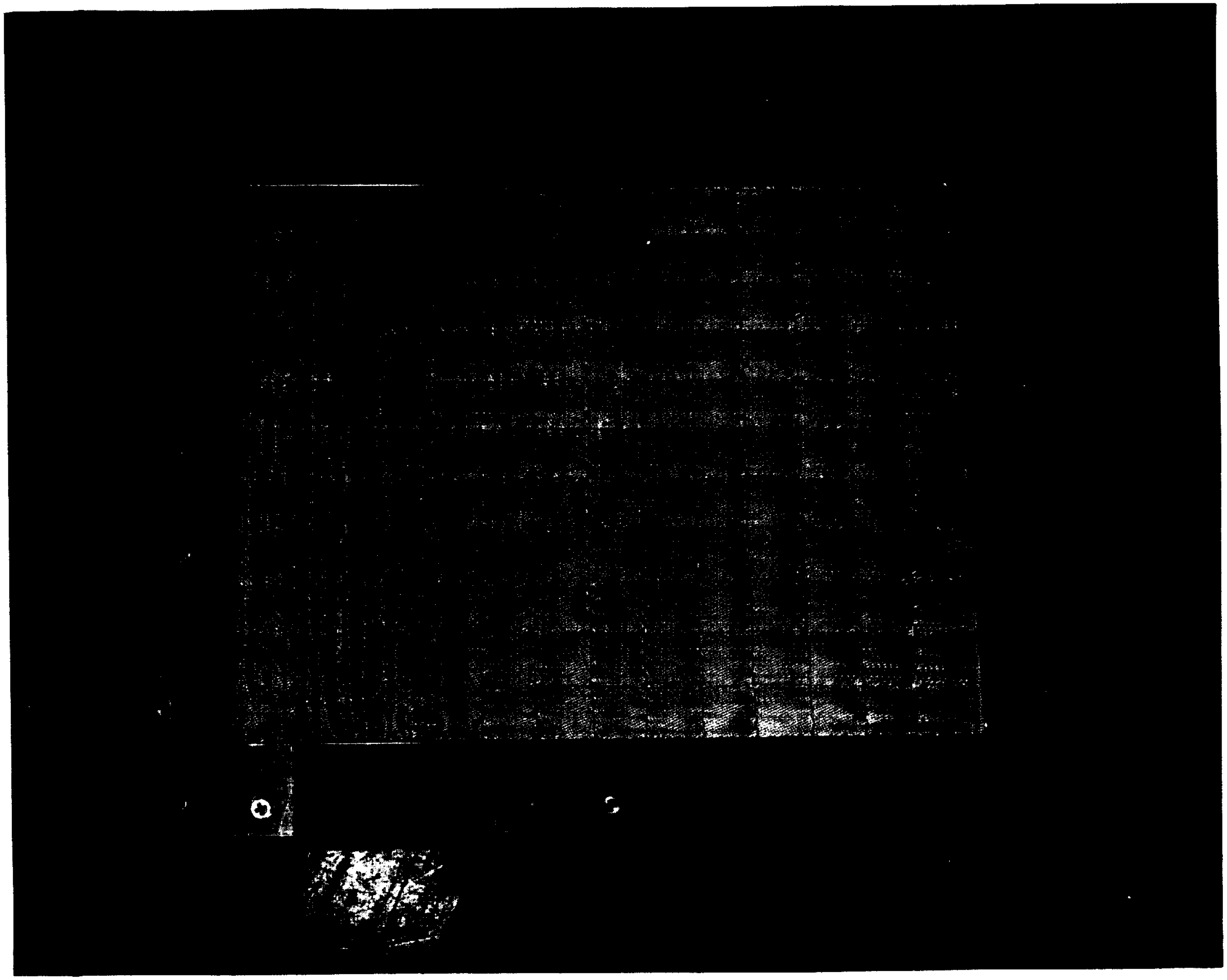
p. Panel 1114, Loose Corner & Densification Repair

Figure 2. (Continued)



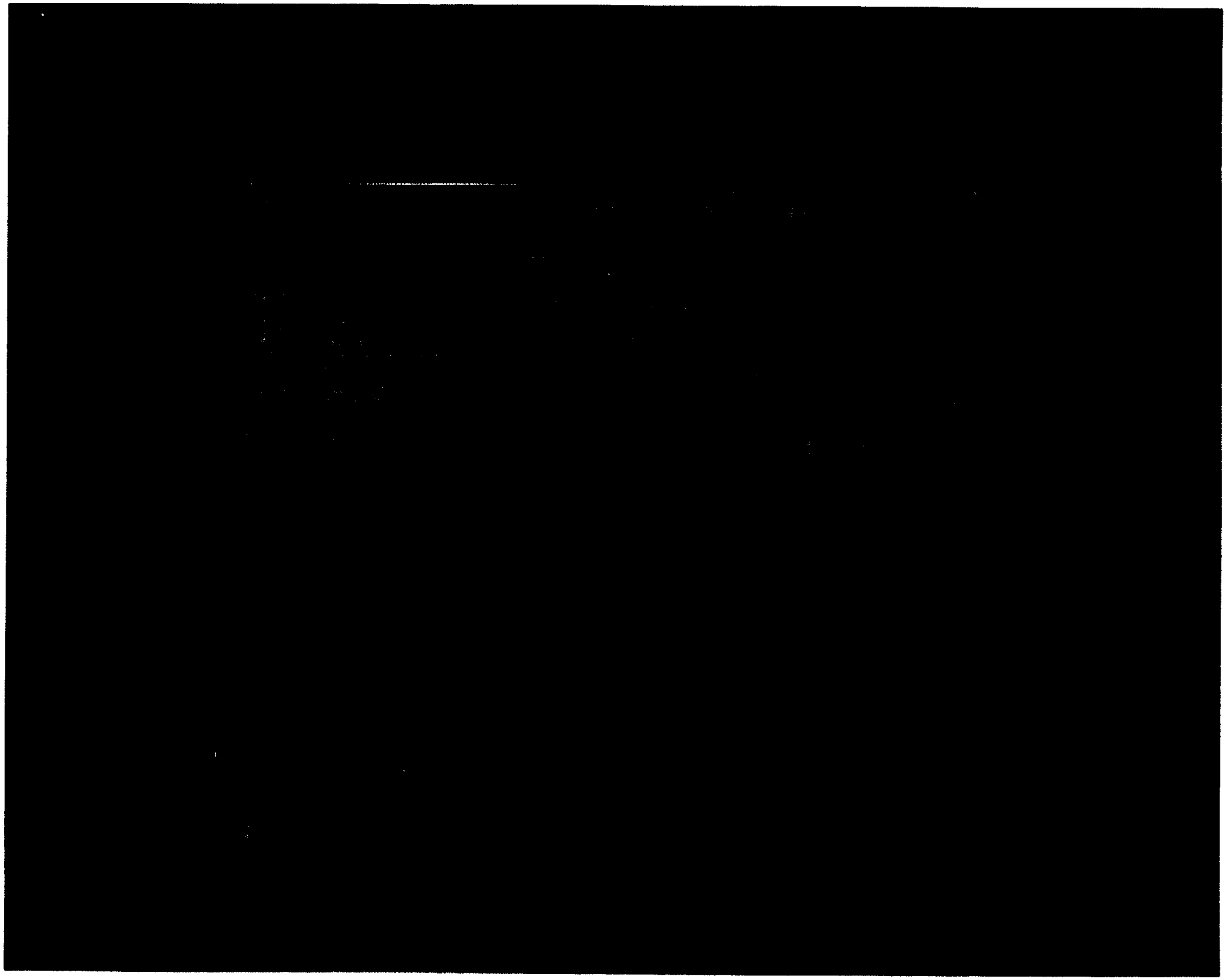
q. Panel 1115, Thick Blanket

Figure 2. (Continued)



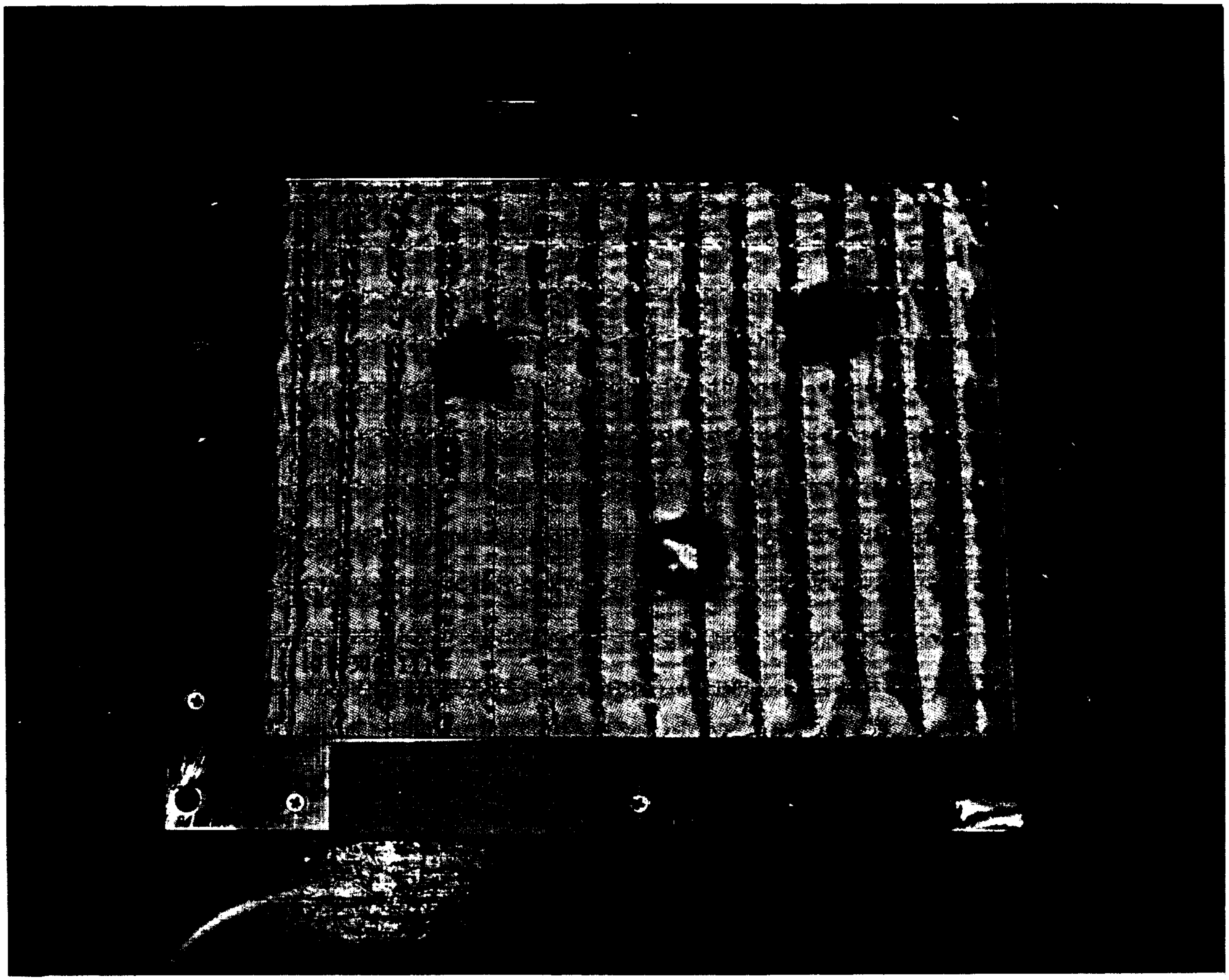
r. Panel 1116, Thick Blanket

Figure 2. (Continued)



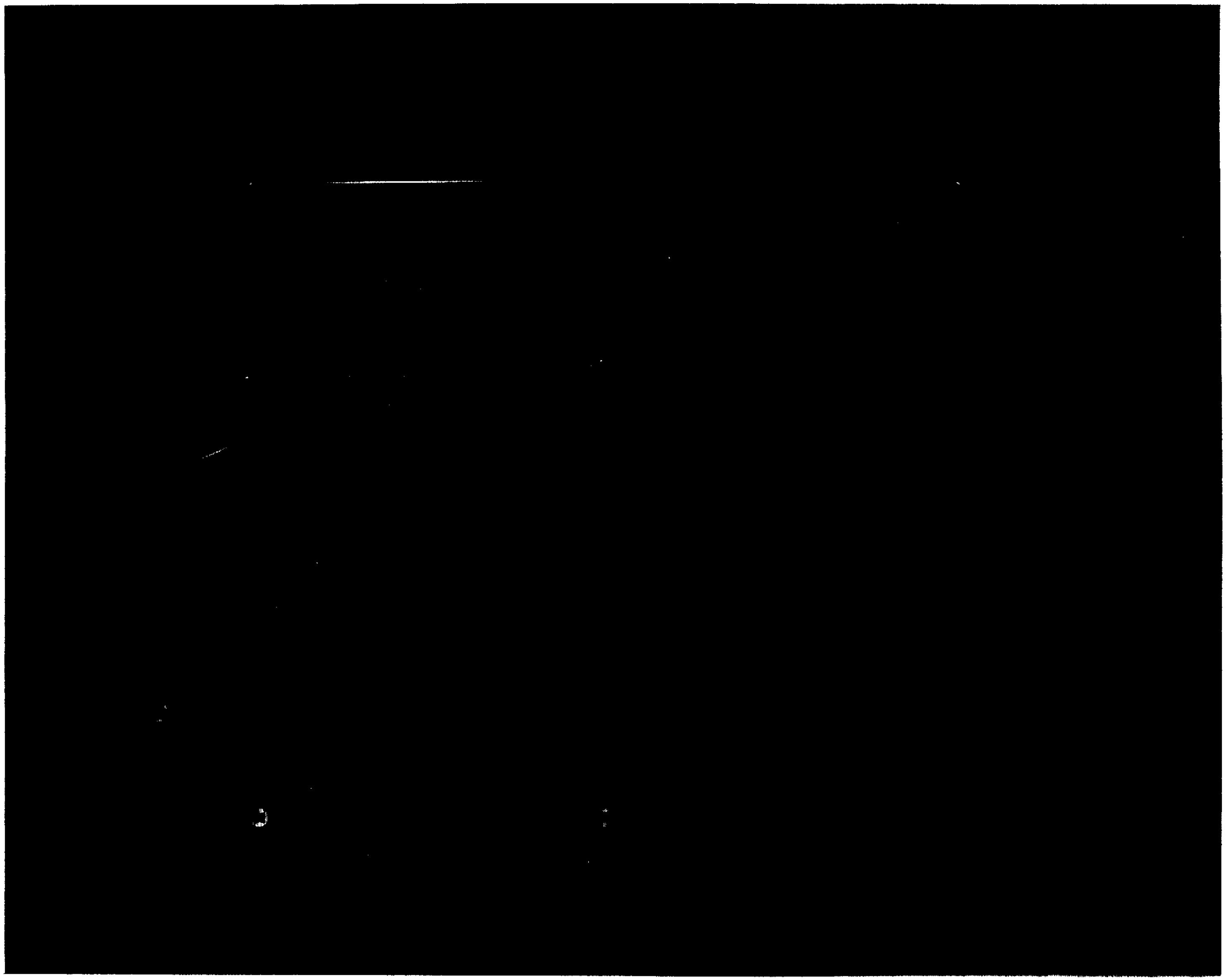
s. Panel 1117, Densification Repair - 1200°

Figure 2. (Continued)



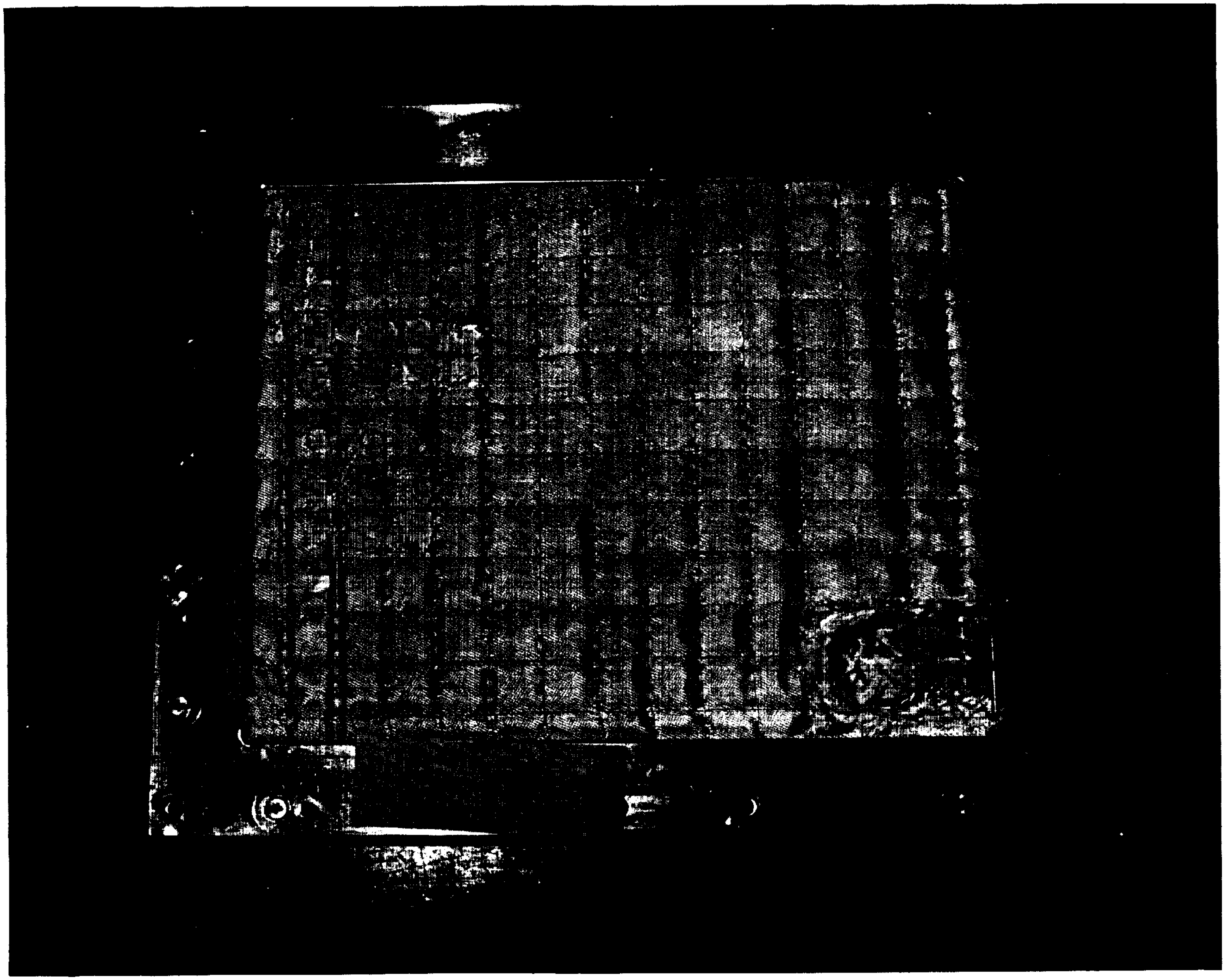
t. Panel 1118, VHT Repair - 1200°

Figure 2. (Continued)



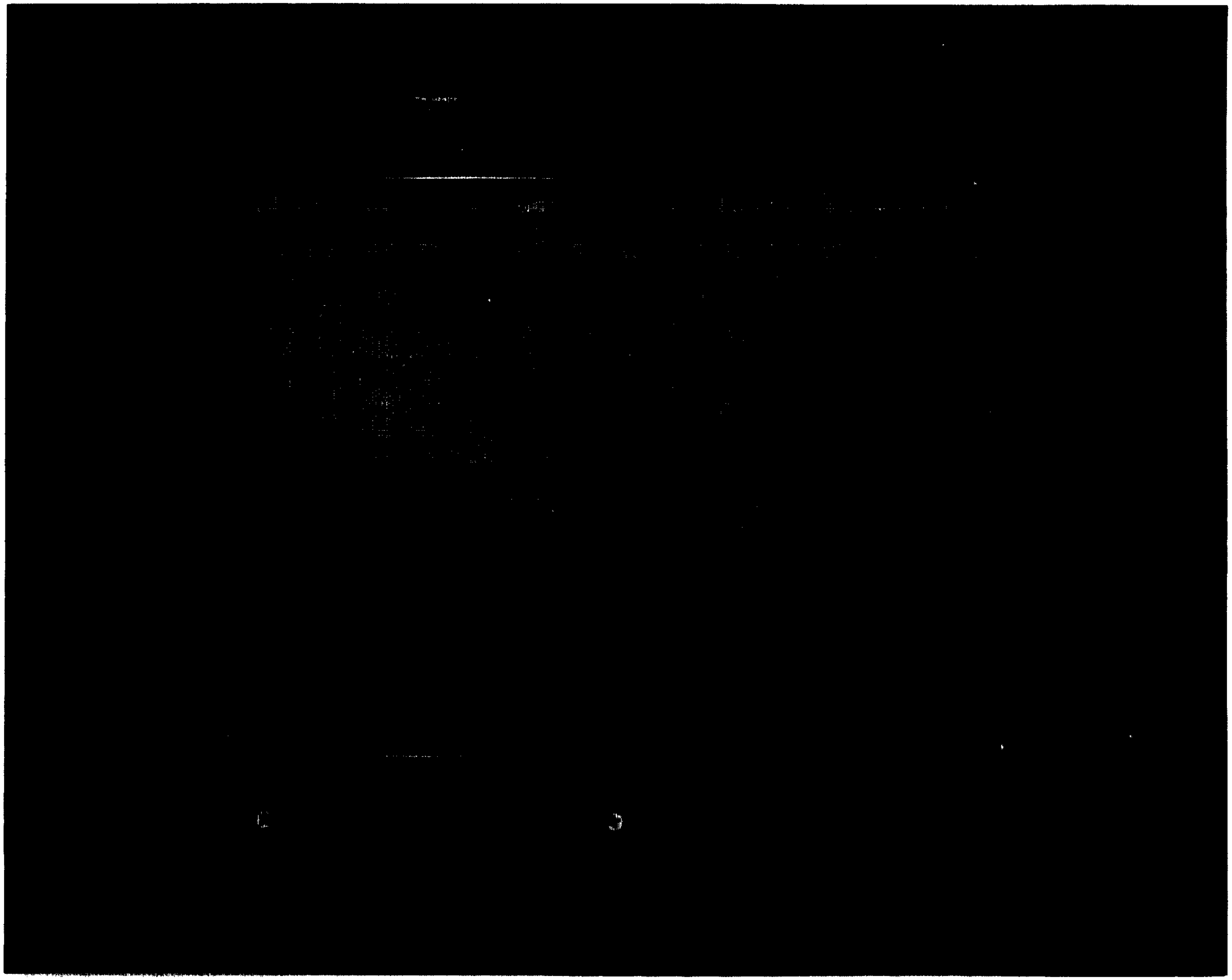
u. Panel 1119, Full Pad Exposed to 1800° in Plasma Arc

Figure 2. (Continued)



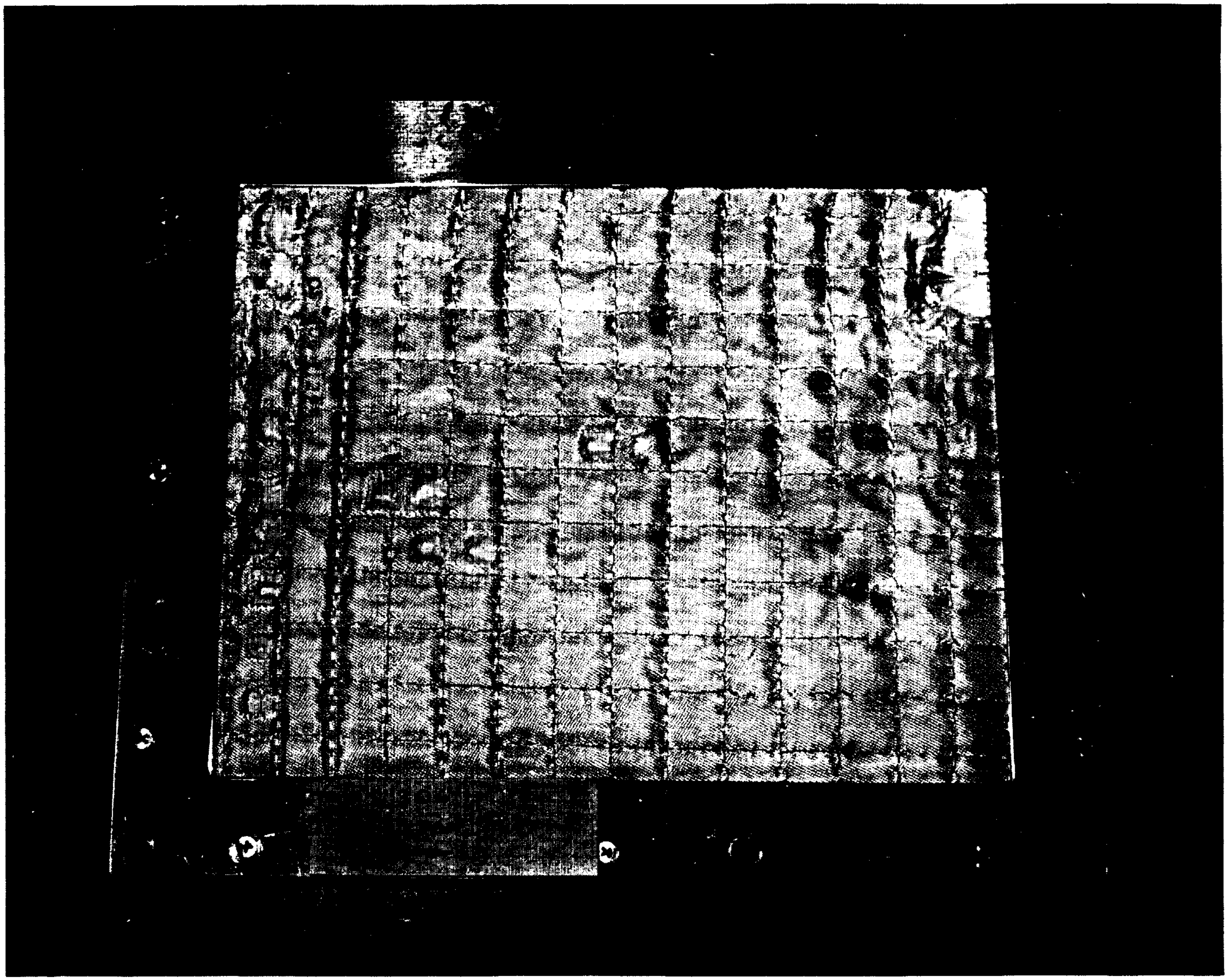
v. Panel 1120, Full Pad Exposed to 1800° in Plasma Arc and Rain

Figure 2. (Continued)



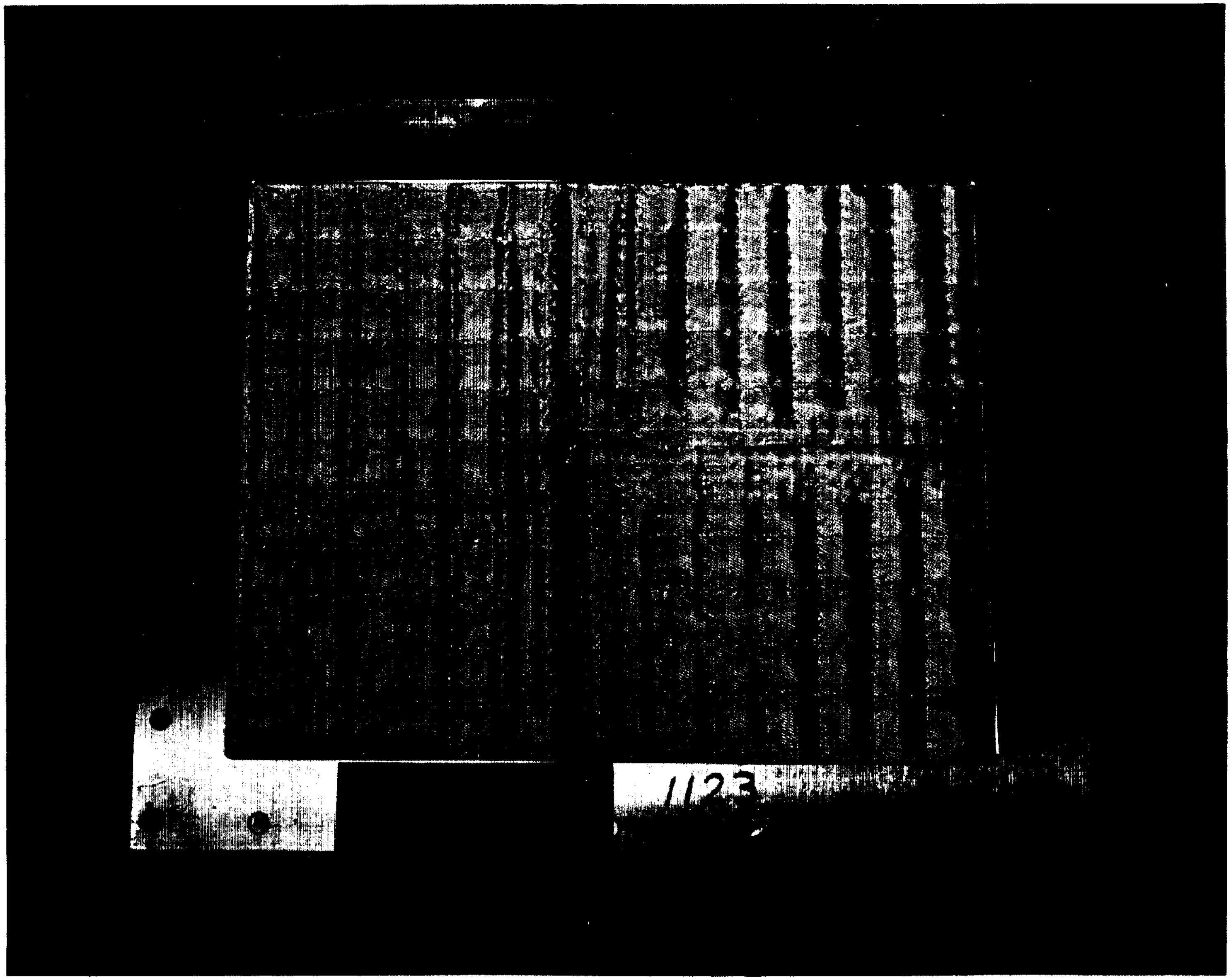
w. Panel 1121, Full Pad Exposed to 1900° in Plasma Arc and Rain

Figure 2. (Continued)



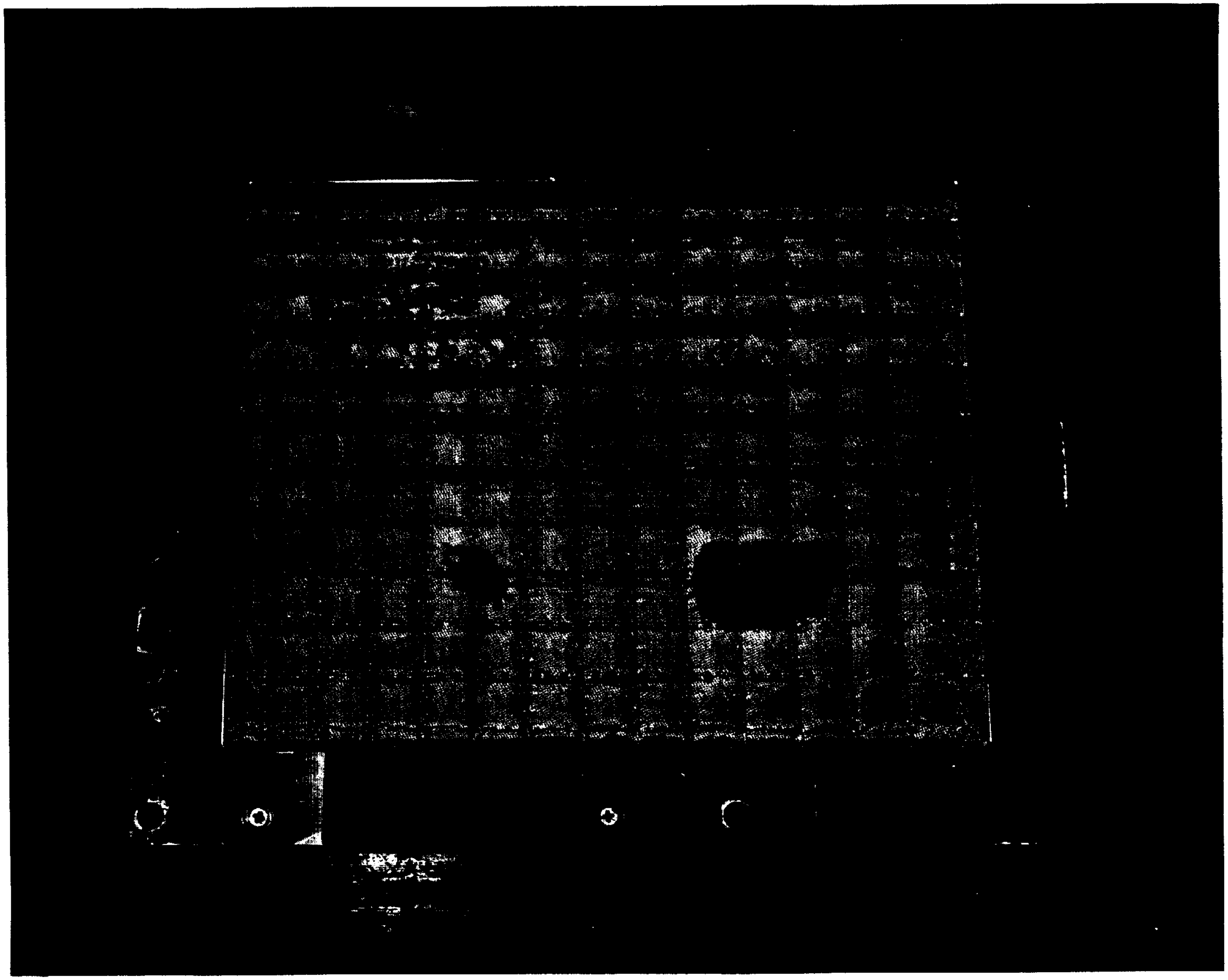
x. Panel 1122, Full Pad Exposed to 1900^{o} in Plasma Arc

Figure 2. (Continued)



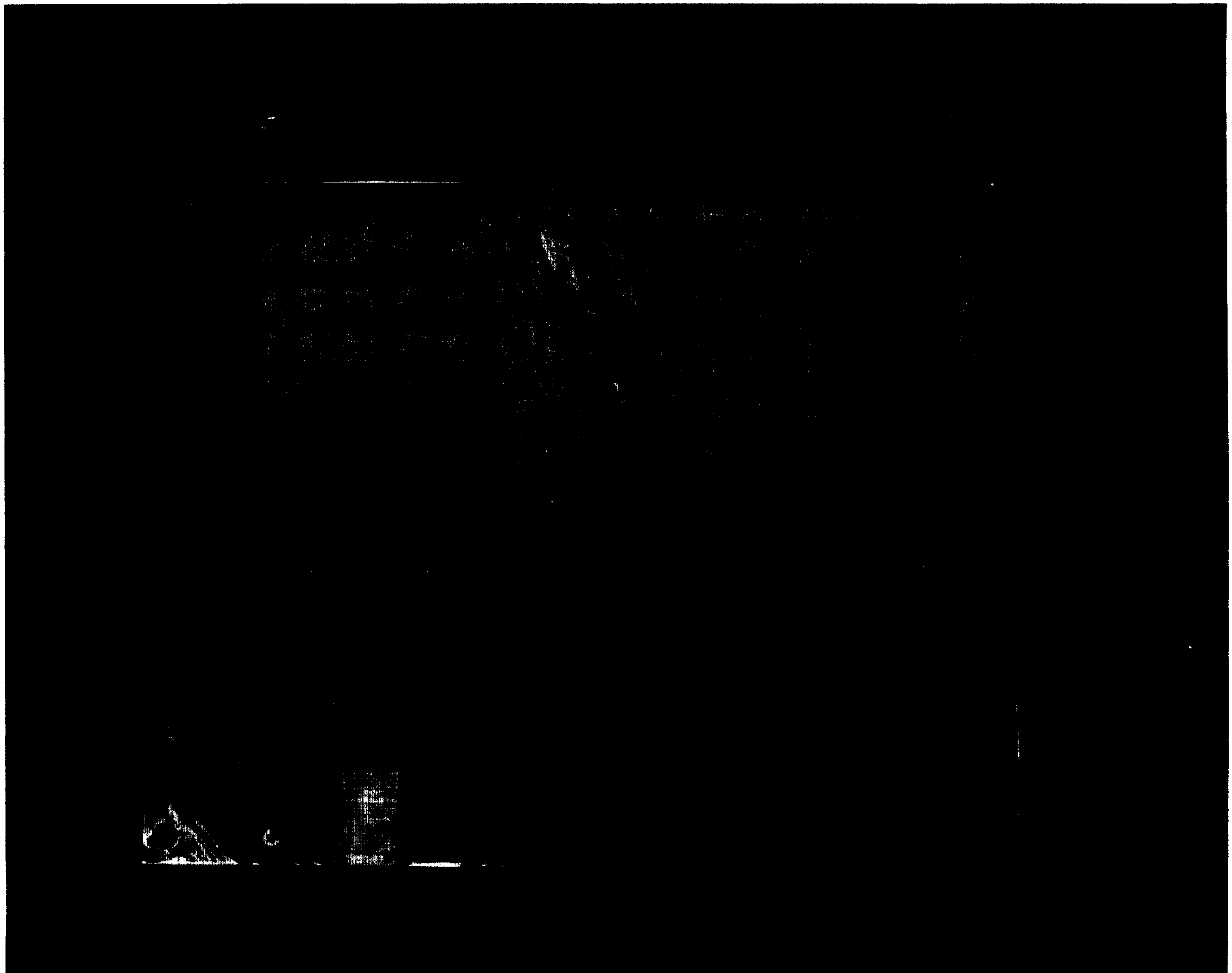
y. Panel 1123, Broken Stitches & Gap Filler

Figure 2. (Continued)



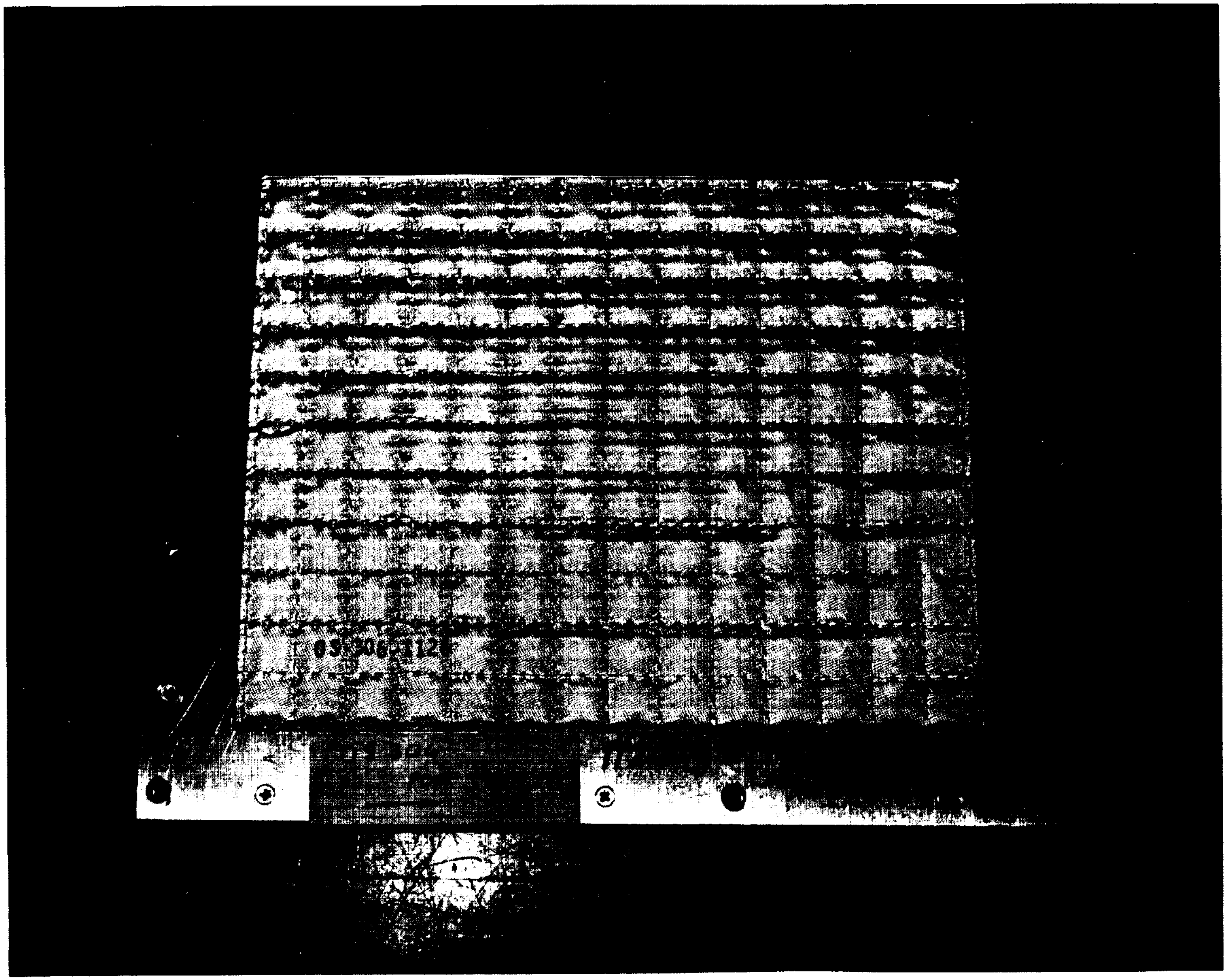
z. Panel 1124, RTV Bleed Thru/Spill - 1800°

Figure 2. (Continued)



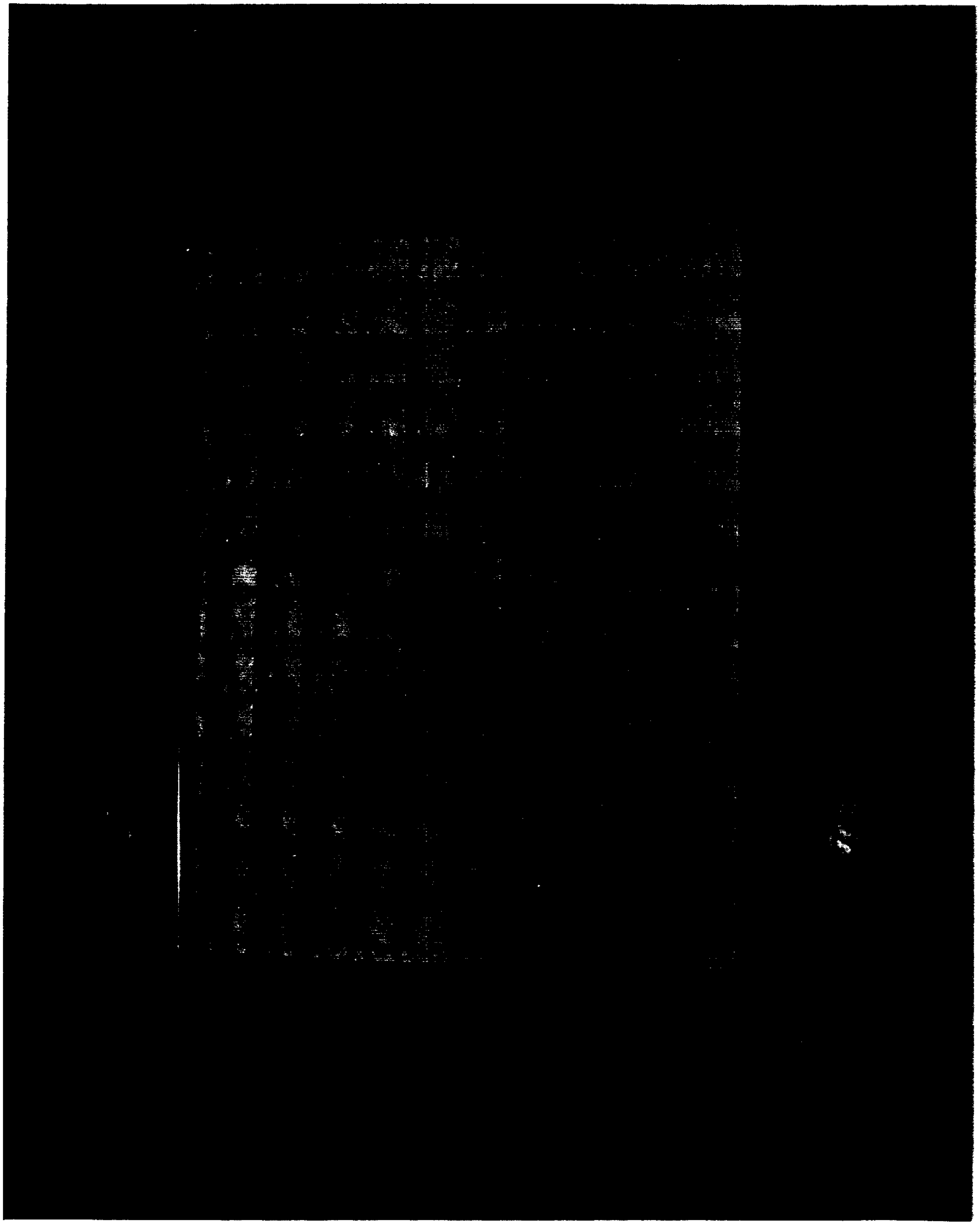
aa. Panel 1125, Forward Facing Step Exposed to 1800° in Plasma Arc

Figure 2. (Continued)



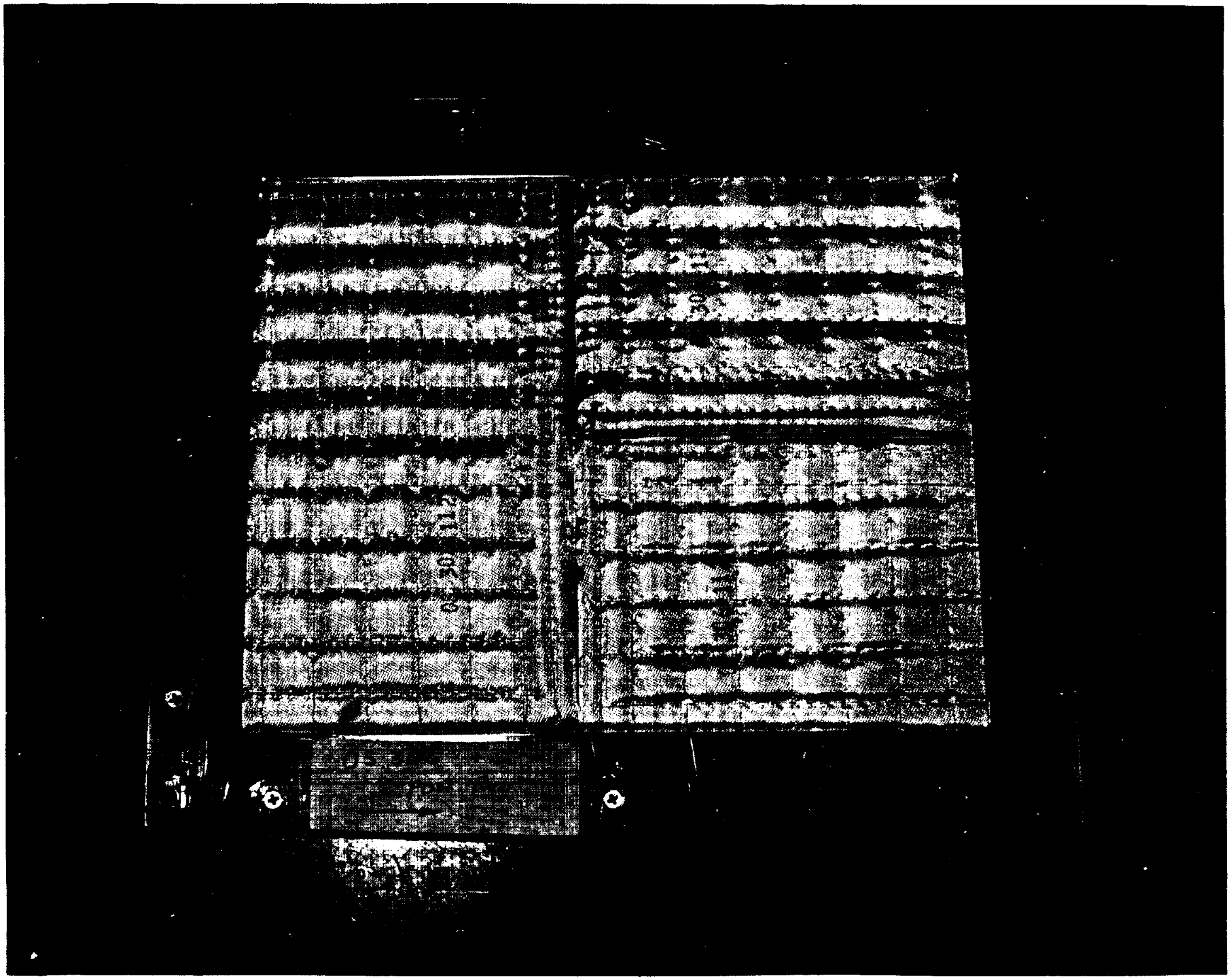
bb. Panel 1126, Hydraulic Fluid Spill - 1800°

Figure 2. (Continued)



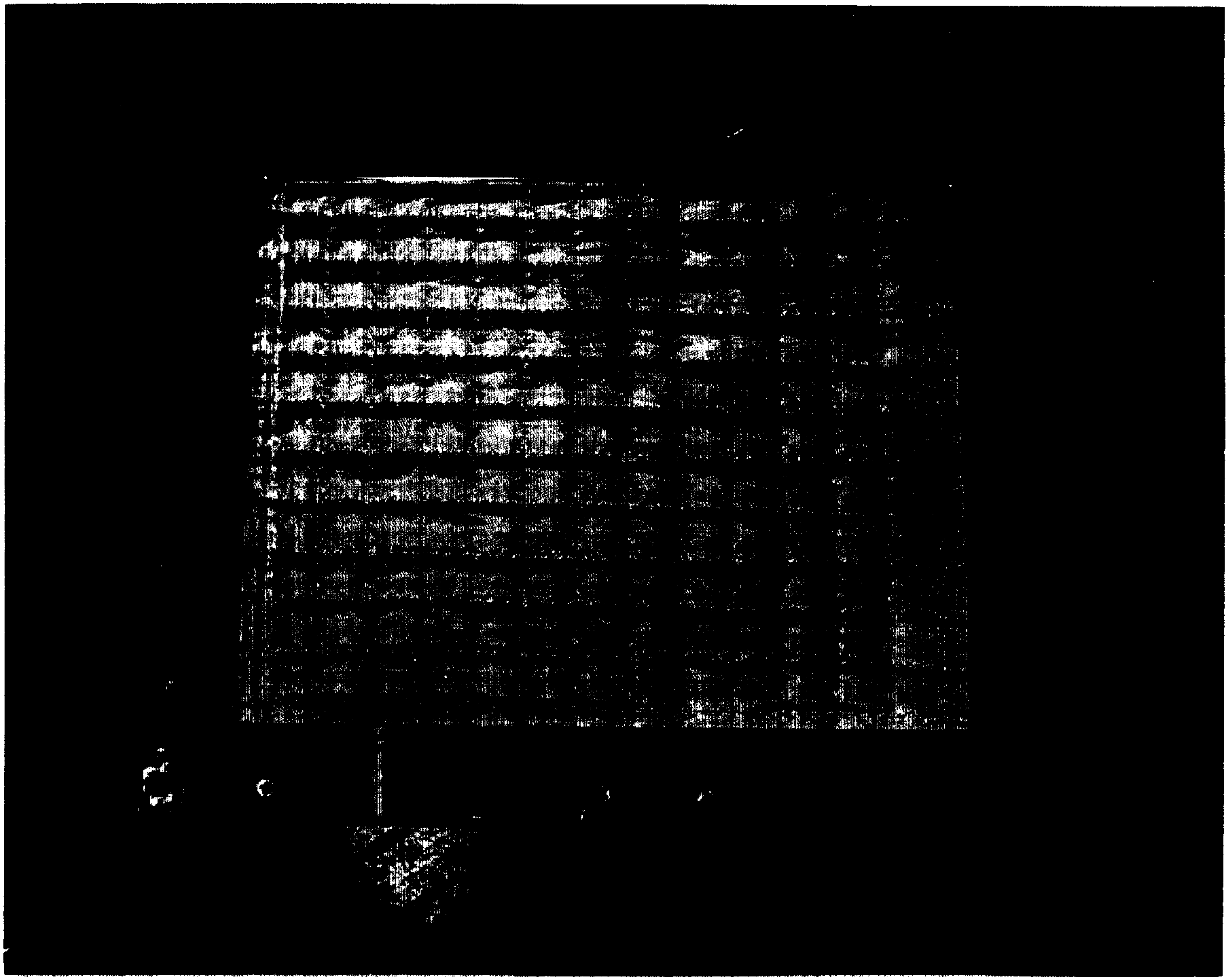
cc. Panel 1127, Thin Blanket

Figure 2. (Continued)



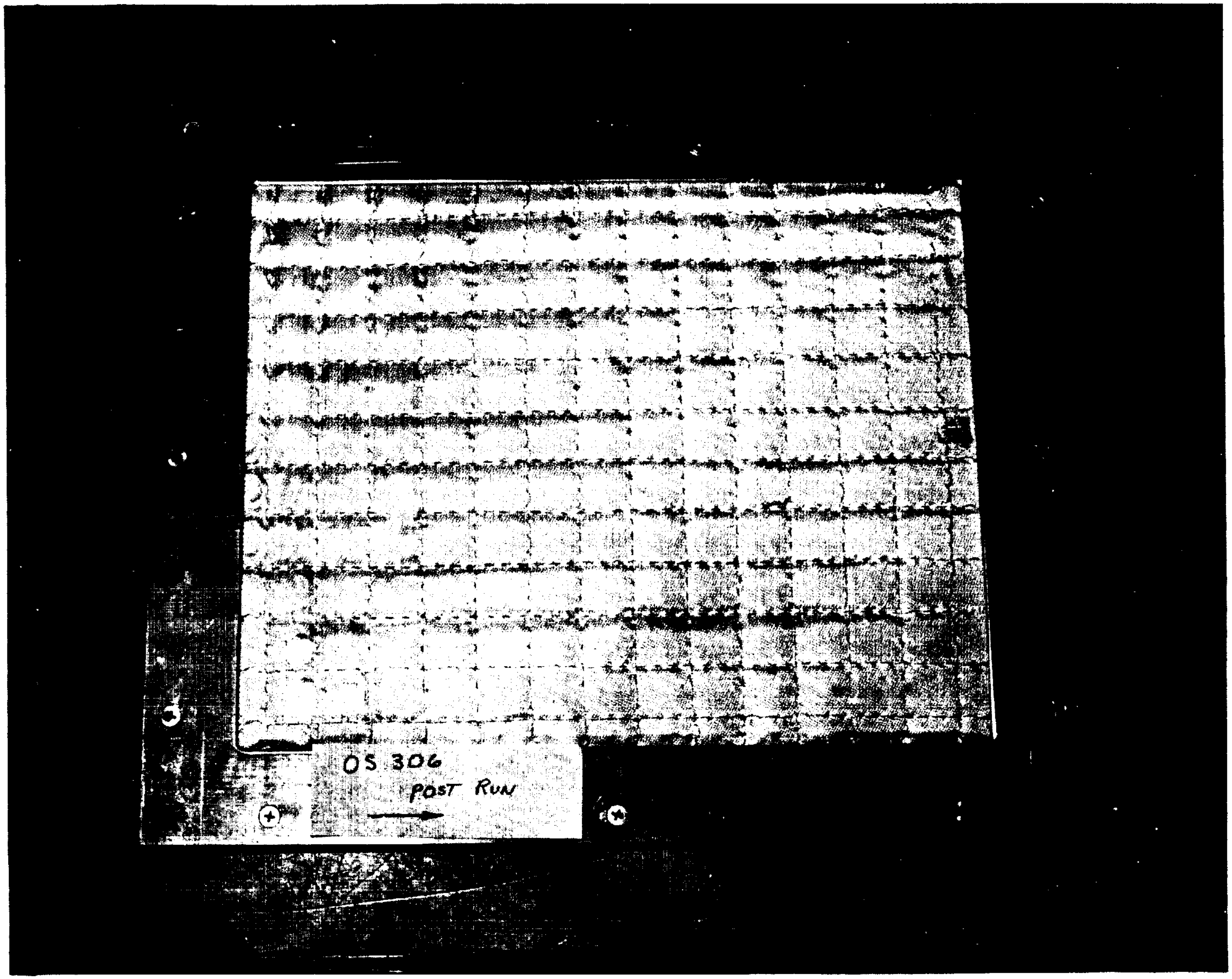
dd. Panel 1128, Loose Edge and Corner

Figure 2. (Continued)



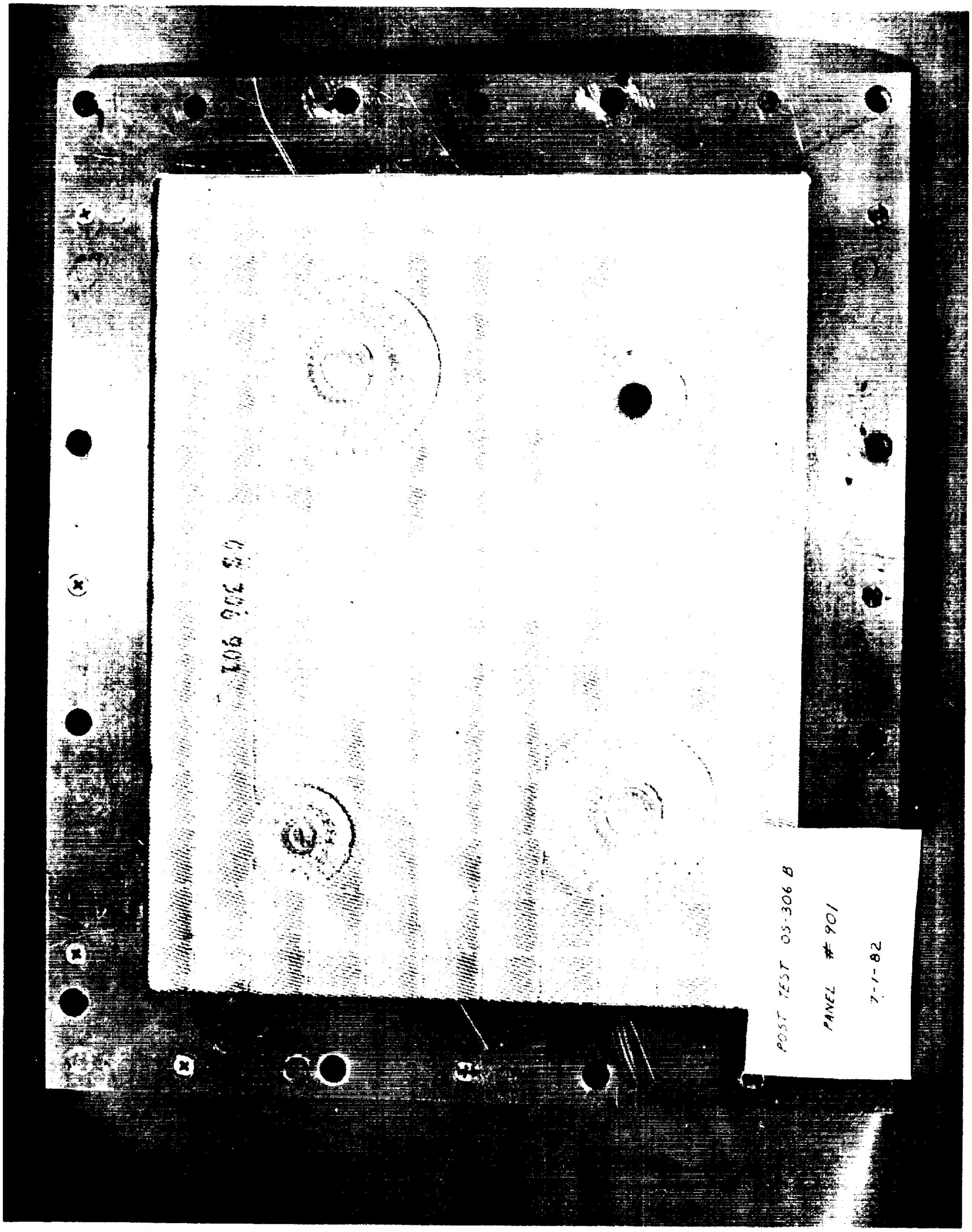
ee. Panel 1129, Δp 2.25 PSI Test Article

Figure 2. (Continued)



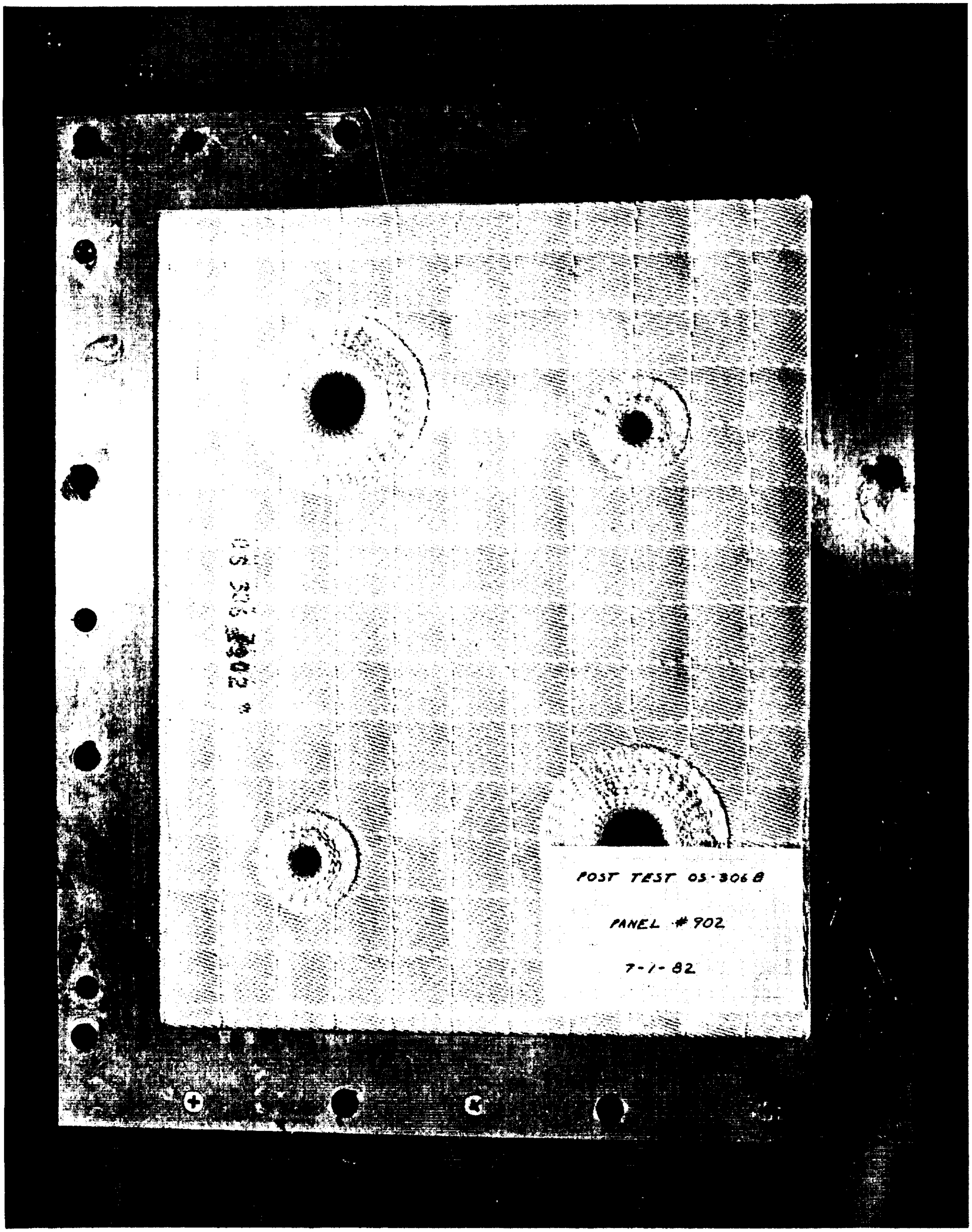
ff. Panel 1700A, 1700° and Rain

Figure 2. (Continued)



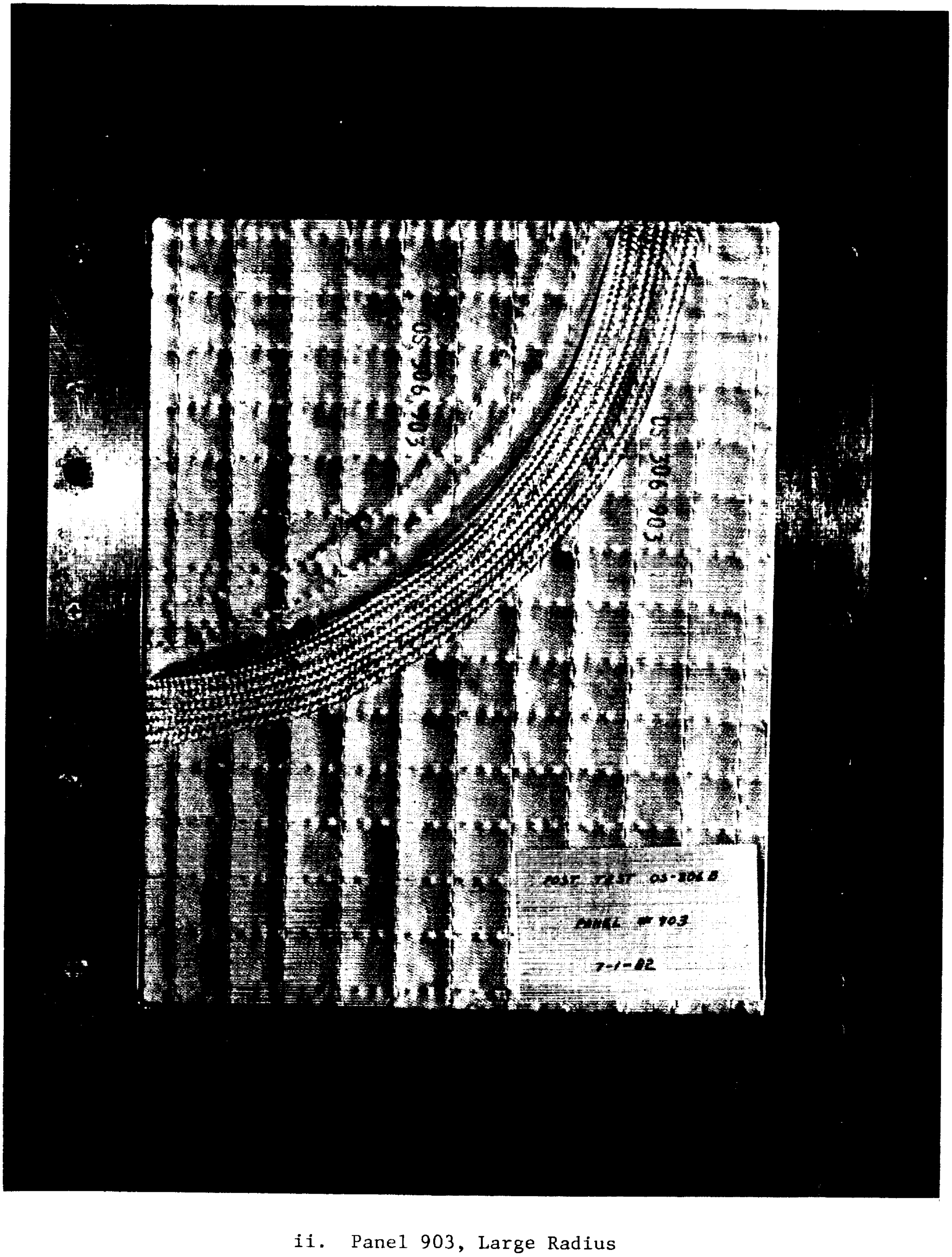
gg. Panel 901H, Plugged Penetrations

Figure 2. (Continued)



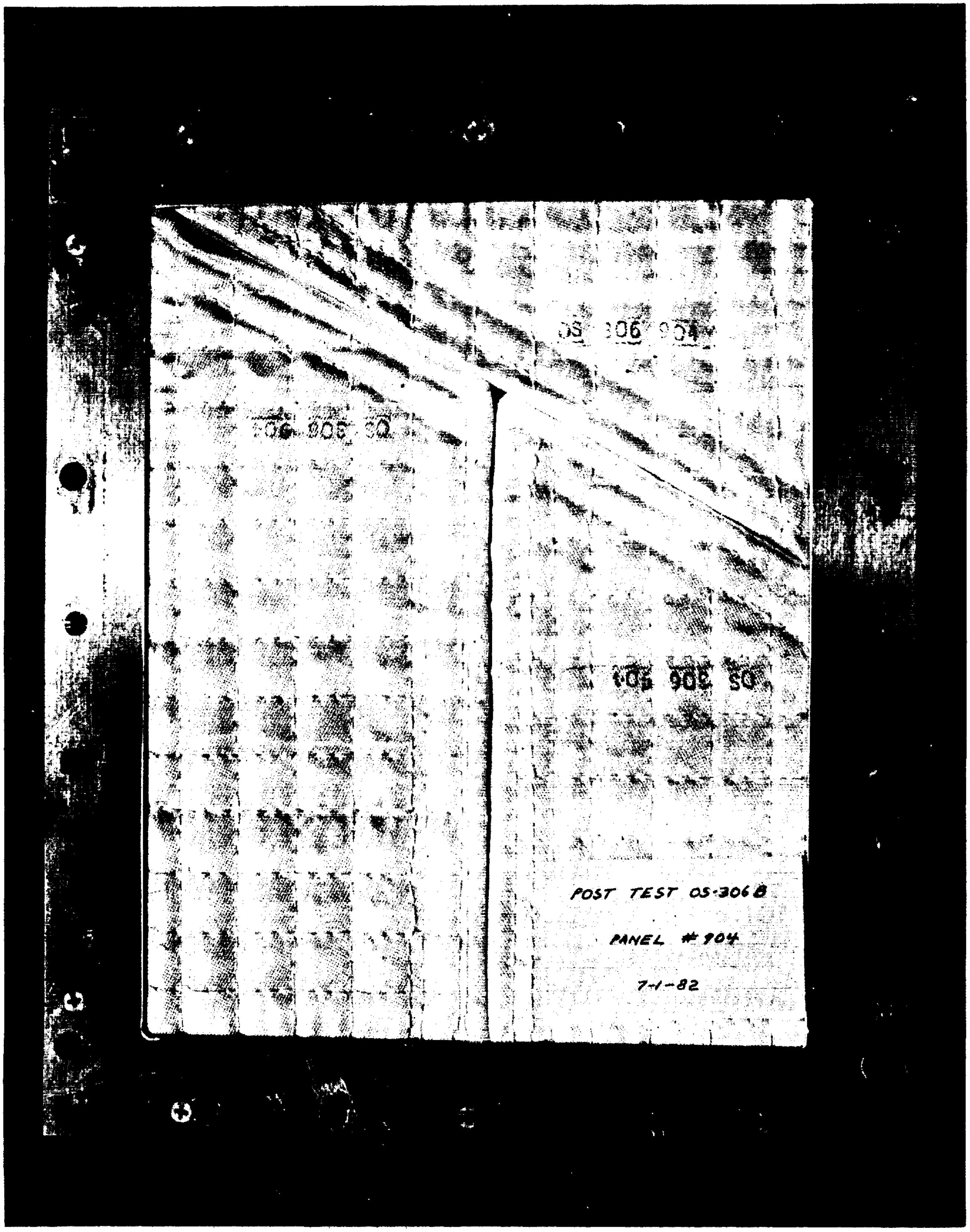
hh. Panel 902H, Unplugged Penetrations

Figure 2. (Continued)



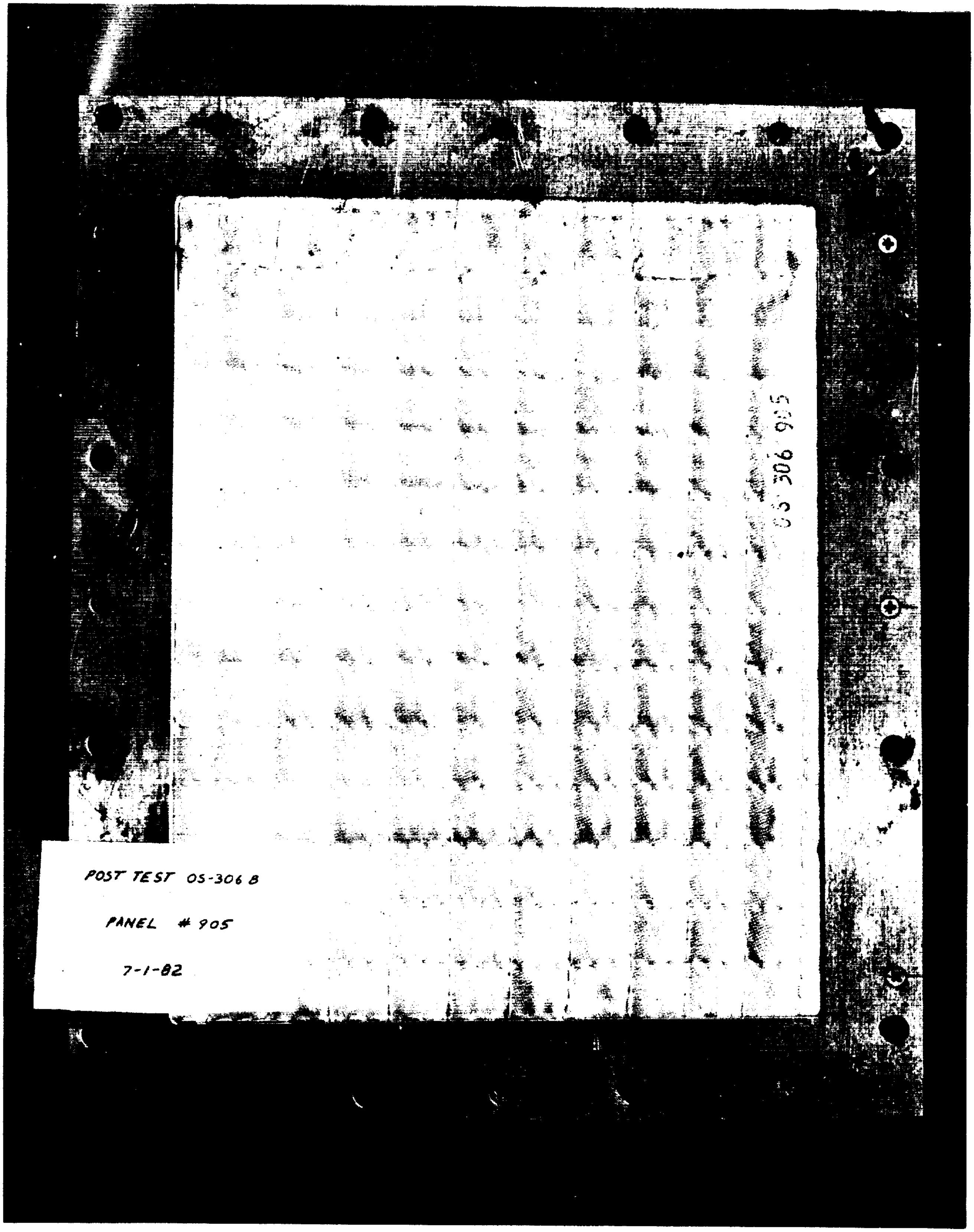
ii. Panel 903, Large Radius

Figure 2. (Continued)



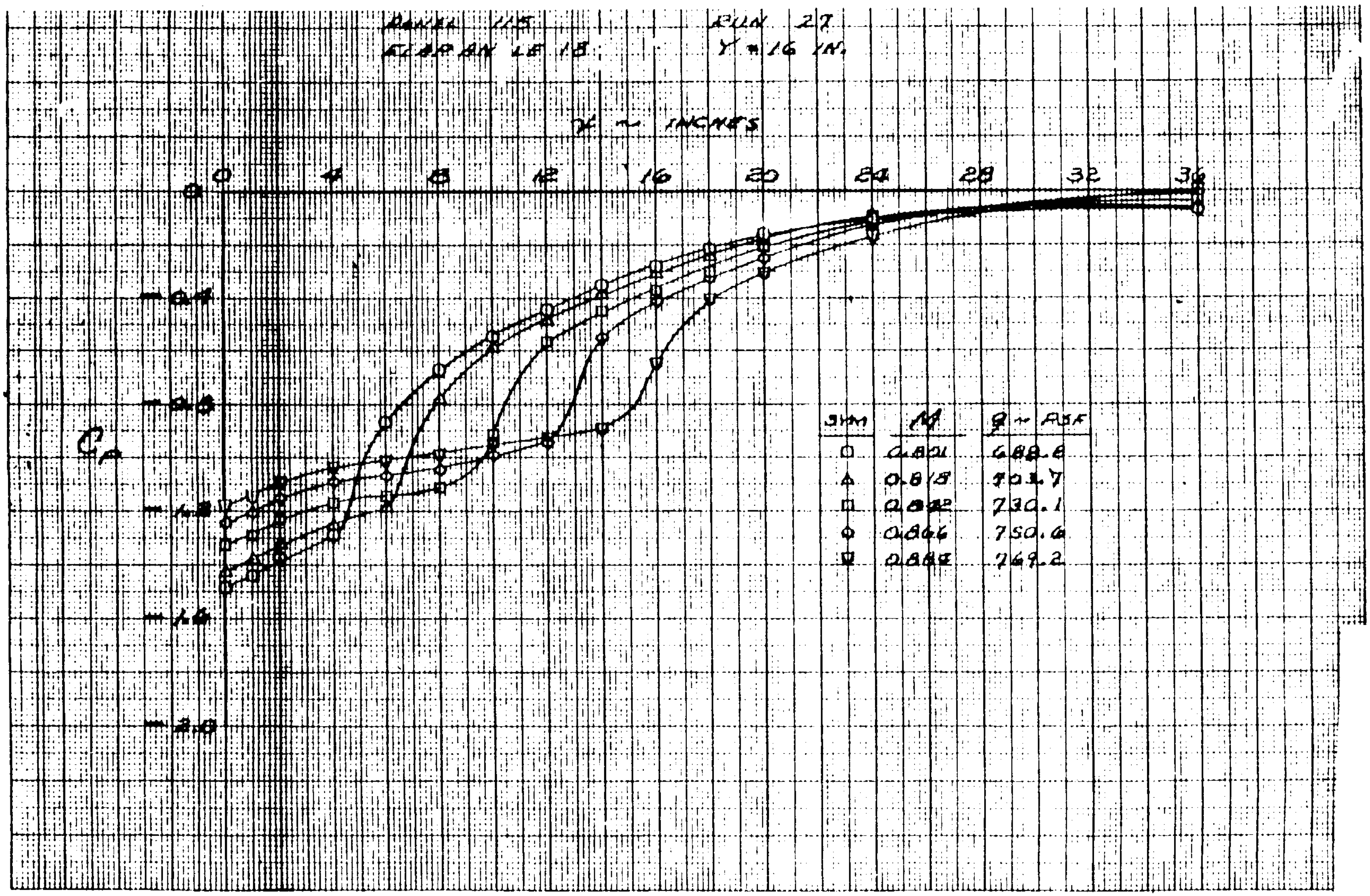
jj. Panel 904, Sharp Corner

Figure 2. (Continued)



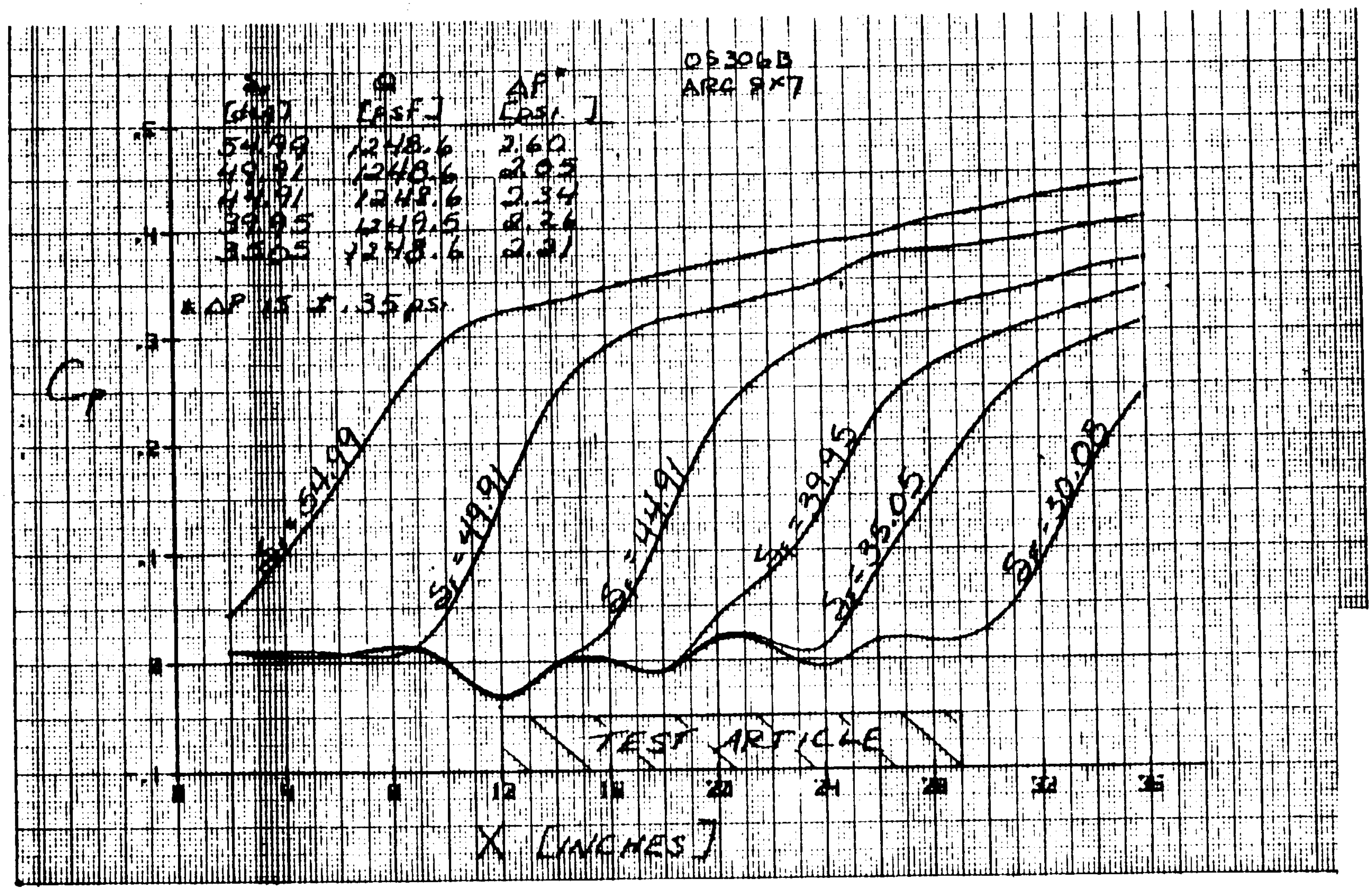
kk. Panel 905, Unjointed; Shock Δp = 2.25

Figure 2. (Concluded)



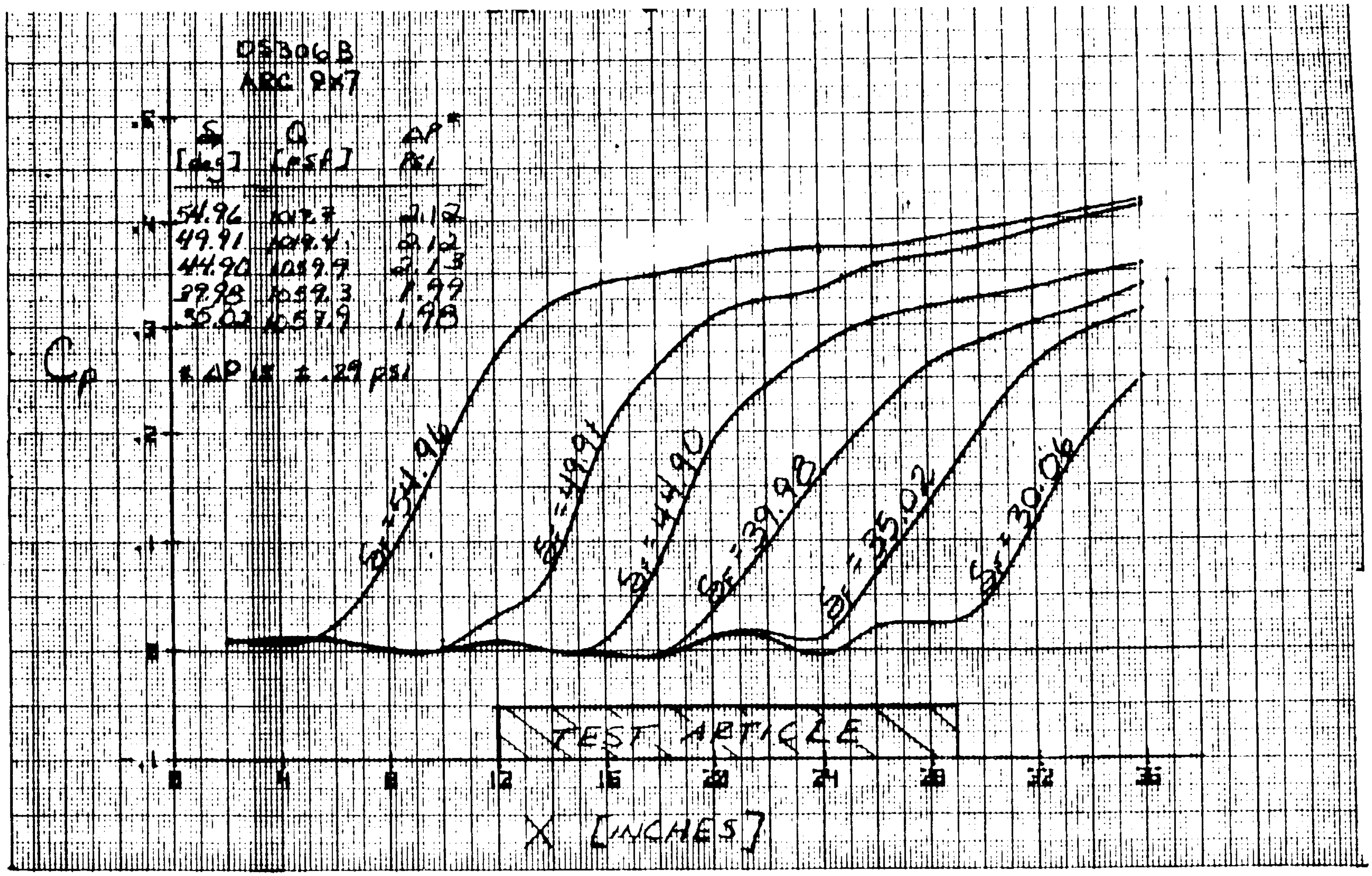
a. Fixture Pressure Variation with Distance Along Panel Edge

Figure 3. Data Figure



b. Pressure Coefficient Versus Distance for Δp = 2.25 psi

Figure 3. (Continued)



c. Pressure Coefficient Versus Distance for Δp = 1.84 psi

Figure 3. (Concluded)

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